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CONTENTS

Page

Wrapping Machine Mechanisms 23
By Frederick Grover

Scanning the Field for Ideas 28

Beryllium Copper Springs Require Modified Design 31
By Louis L. Stott

Localized Stresses Menace Every Design 34
By V. L. Maleev

Gear Makers Study Welded Plus Cast Design 37

Consider the Pump—Vital Factor in Machine Performance—Part II—Liquid Pumps 38
By Allen F. Clark

Motor Mounting Expands Range of Saw Trimmer 41

Cam Charts Eliminate Cut and Try Methods 43
By Frank Schubert

New Machines Indicate Design Trends 45

Design Features n New Machines 46

Design and Development Turning Losses into Profits (Editorial) . 48

Professional Viewpoints 49
Men of Machines 51
Obituaries 54
Book Reviews 56
Noteworthy Patents 62
New Materials and Parts 70
Calendar of Meetings 79
Manufacturers Publications 86
Research Publications 87
Business Announcements 89
Cross Sections 89
Topics 20

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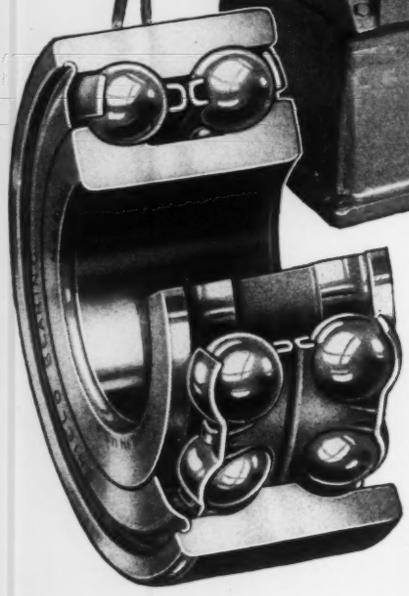

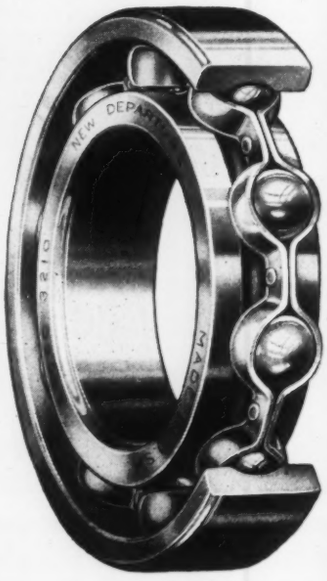

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Itemized Index

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Design Calculations:

Beryllium springs, Edit. 31, 32, 33

Design Problems:

Beryllium, applying, Edit. 31, 32, 33, 85R
Cams, developing, Edit. 43, 44
Castings and weldings, combining, Edit. 37, 80R
Hydraulic and electrical controls, combining, Edit. 29L
Machine range, widening, Edit. 41, 42
Motions, securing complex, Edit. 23, 24, 25, 26, 27, 90R
Noise, eliminating, Edit. 30
Pneumatic devices, utilizing, Edit. 29
Pumps, utilizing liquid, Edit. 38, 39, 40, 82R, 83L, 84R
Shafting, reducing stresses in, Edit. 34, 35, 36
Springs developing beryllium, Edit. 31, 32, 33, 85L
Stresses, reducing localized, Edit. 34, 35, 36
Weight, integrating, Edit. 28, 29L

Materials:

Alloys (Nickel), Adv. 61
Alloys (Steel), Edit. 20R; Adv. 55
Beryllium copper, Edit. 31, 32, 33, 85R
Felt, Adv. 82L, 84L
Molybdenum, Adv. 67
Plastics, Edit. 70R, 72R; Adv. 88L
Zinc, Adv. 63

Mechanisms:

Cam, Edit. 24, 25, 29, 43, 44
Compensating, Edit. 64R
Conveying, Edit. 29R, 30L
Crank, Edit. 24L, 26L
Doffing, Edit. 66R, 68R
Feeding, Edit. 90R
Geneva, Edit. 26
Indicating, Edit. 64R, 66R
Integrating, Edit. 28
Intermittent, Edit. 26
Pneumatic, Edit. 29
Slide, Edit. 49
Stranding, Edit. 62R, 64R
Tensioning, Edit. 27, 90R

Organization and Equipment:

Engineering department, Adv. 52L, 56L, 64L, 76L
Machine motions, charting, Edit. 25R

Parts:

Bearings, Edit. 70R, 77L, 78R, 80R, 81L, 82R; Adv. 6, 14, 19, 53, 54L, 65, 73R, 78L
Brakes, Edit. 73L, 74R
Cast parts, Edit. 37, 80R
Clutches, Edit. 73L, 74R; Adv. 83R, 92
Controls (Electrical) Edit. 29L, 72R, 73L, 76R, 77L; Adv. 3, 10, 11, 57
Conveyors, Edit. 29R, 30L
Counters, Adv. 69
Couplings, Adv. 72L, 78L
Drives, Edit. 29R, 40, 72R, 78R; Adv. 2, 21, 71, 75R, 79R, 82L, 85R, 86, 91
Fastenings, Adv. 18, 66L, 74L, 87R
Forgings, Adv. 12
Gears, Edit. 26R, 27L, 37, 80R, 81L; Adv. 81R
Hose, Edit. 73L
Hydraulic equipment, Edit. 29L
Lubrication and lubricating equipment, Edit. 50R, 82R
Motors (see also under Drives), Edit. 28, 29L, 30L, 41, 42; Adv. 9, 13, 17, 22, 58L, 60L, 62L, 68L
Packing glands and packing, Adv. 4, 16, 77R, 80L
Plugs (Electrical), Edit. 75L, 76R
Pumps, Edit. 38, 39, 40, 82R, 83L, 84R; Adv. 72L, 74L, 80L, 88L
Shapes, Adv. 70L
Shims, Edit. 64R; Adv. 70L
Springs, Edit. 31, 32, 33, 42R, 85R; Adv. 15
Valves, Edit. 30, 74R, 75L
Welded parts and equipment, Edit. 37, 80R; Adv. 8, 59

Principles:

Hydraulic, Edit. 29L

Key: Edit., Editorial Pages; Adv., Advertising Pages; R, Right hand column; L, Left hand column

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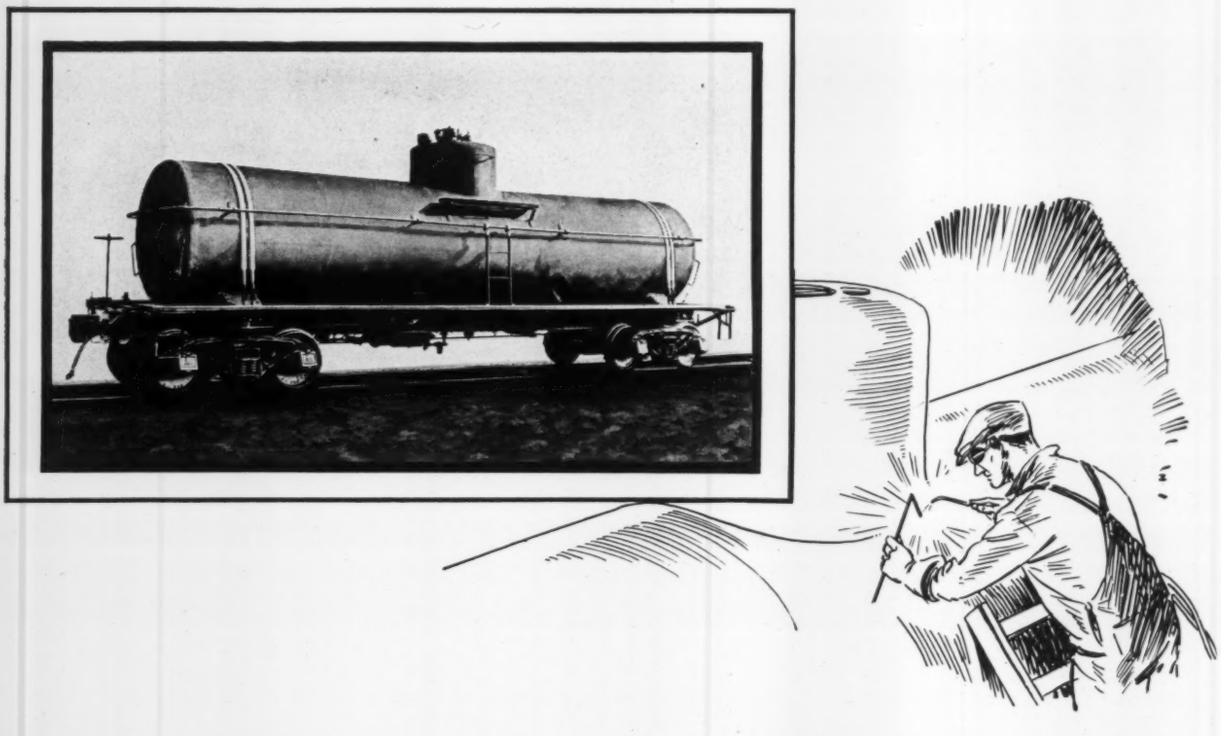

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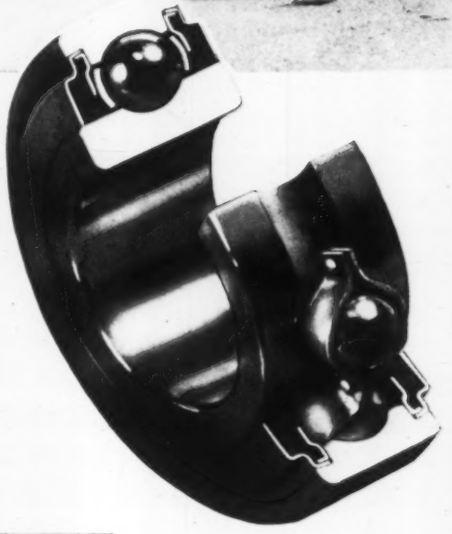

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Topics . . .

DEVELOPMENTS in materials from month to month offers a symbolic yard stick by which to measure to an appreciable extent the progress in design of machinery. In other words the march toward perfection lies largely in the direction of the metallurgical laboratory. That the design engineer is utilizing every opportunity to improve design by the use of newer materials is shown in a report made by the president of International Nickel Co. at the annual stockholders meeting. He disclosed that twenty per cent of the world sales of Inco nickel in 1935 went into motor cars, trucks and busses. Twenty-seven per cent of the total amount sold was used in railroad equipment, farm implements, general machinery, etc., as against fifteen per cent in 1933.

♦ ♦ ♦

Castings also are setting new records. At Otis Steel Co.'s Riverside plant in Cleveland a commercial steel casting weighing 400,000 pounds recently was taken from the sand mold where it had been cooling for nearly three weeks. It is one of four being made for use as mill housings for the largest four-high mill ever built, and will support rolls weighing 235,000 pounds in addition to bearings and fittings.

♦ ♦ ♦

Plans to expand its organization for the advancement of welding research has been announced by the Welding Research committee of the Engineering Foundation. Already sixty investigations, guided by a subcommittee on fundamental research, are underway in universities alone, and many more are going forward in industrial and federal laboratories. Another project, indicating the current interest in research, is the temperature research foundation established and maintained by Kelvinator Corp. It will aim to advance standards of health, comfort, and leisure among American consumers in the fields of heating, food preparation and preservation, and air conditioning in home, office and factory. Edward Heitman, Kelvinator chief engineer, is director of the foundation.

♦ ♦ ♦

Engineers are constantly on the lookout for such developments as the new type of stainless steel invented by F. F. Gordon of a Sheffield (England) steel works. His process consists in giving ordinary steel a coating of stainless steel by bonding, resulting in a coating of less than 0.001 inch. This innovation which is cheaper than present methods, it is claimed, opens up many new avenues in the use of stainless steel.

♦ ♦ ♦

The foregoing British discovery brings to mind another achievement in that country, the new Cunard-White Star superliner QUEEN MARY. In this vessel fifteen tons of stainless steel is used in the kitchen and pantry equipment. Also outstanding in the design of the ship are the radio facilities which will enable passengers in any of the five hundred staterooms to hold radio telephone conversations with any part of the world. ....

♦ ♦ ♦

The famous designer of clippers and amphibions, Igor I. Sikorsky says that transport flying in the stratosphere is possible but impractical at the present time. He made this observation after accompanying Capt. Boris Sergievsky, chief test pilot of Sikorsky Aircraft, on a record-breaking flight.

♦ ♦ ♦

Keep television on an experimental basis, urged T. A. M. Craven, chief engineer of the federal communications commission in a recent report. By so doing, he declared, the major economic effects on radio broadcasting, newspapers and the motion picture industry can be predicted more accurately before the commission gives consideration to issuing commercial television licenses.

MACHINE DESIGN

Wrapping Machine Mechanisms

By Frederick Grover

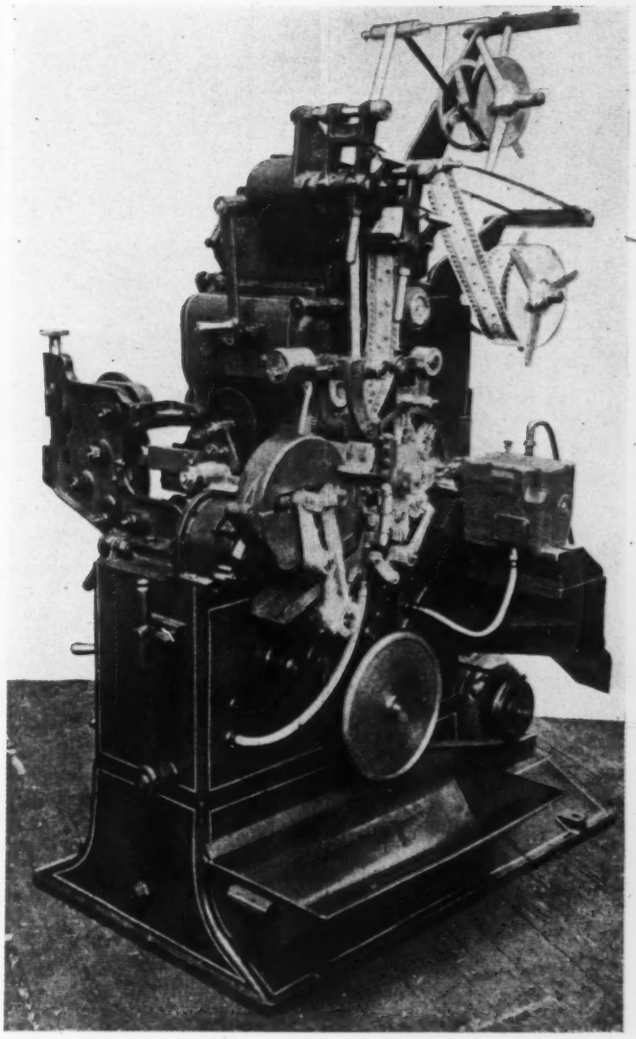


Fig. 1—Widely varying types of movement are found in wrapping machine

A WRAPPING machine is alive with movement. Elements rotate with constant and variable angular velocity, others reciprocate with varying velocities and have intermittent times of rest. Successive sheets of wrappers have to be cut off and registered with the oncoming object. Lines of gum must be applied at strategic points. All these movements must be synchronized with precision. There is sufficient matter here for at least a volume, but this article must be limited to a very restricted description of some of the means employed.

All machines for wrapping derive their ac-

MECHANISMS employed in intricate wrapping machines, and the careful steps traced in determining exact proportions can be of value in many other types of machines. Mr. Grover, chairman, Forgrove Machinery Co. Ltd., Leeds, England, presented the paper from which this article is abstracted at a meeting of Institution of Mechanical Engineers.

tion from a shaft rotating at constant speed. The problem of the designer is to convert rotary motion into reciprocating movements of a specific character, and into other rotary movements with varying periods and dwells. Finally, there are endless combinations that may be effected by mechanical means.

In this class of machinery the external work done is insignificant, and hence wear and tear is the result of internal forces caused by the motions of the parts themselves. In all mechanical actions, such for instance as the familiar crank and connecting rod and the perhaps less familiar geneva motion, there are definite positions where the acceleration of the driven part has its maximum value and other well-defined points where there is no acceleration. On the other hand, a cam movement may be made which will give a constant acceleration, thus equalizing the wear.

Allot Times to Each Movement

When high speeds are required it is specially important to allot the times to each movement so that no disproportionate rate of change of motion occurs in one element which would mar the otherwise rhythmic action and set up severe local stresses in an overdriven member. To state the problem more precisely, let us imagine that three separate movements have to be synchronized, represented by 4, 9, and 36 units of length to be traversed by the respective parts in one cycle of the machine. The question arises, what time should be allotted to each movement so that the acceleration will be the same in each case? From well-known principles it is demonstrable that the times should be proportional to the square roots of the distances. Thus the operating times would be in the proportion of 2, 3 and 6 and the cycle would contain 11 parts. In a cycle of 360 degrees, 65, 98 and 197 degrees should, therefore, be allowed for the respective movements.

The simplest way of obtaining a reciprocating movement is by means of the crank and connecting rod, and wherever possible this gives the cheapest form of control. But the movement occupies the whole cycle and cam movements are therefore also very generally used. A to-and-fro straight-line movement can be derived from a continuously rotating crank which does give a moderate period of dwell at one end of its stroke.

Gives Constant Acceleration

There are two well-recognized forms of cam, namely the harmonic type and the so-called gravity cam. The first of these gives a motion similar to that given by a simple crank and connecting rod, in which the acceleration is greatest at each end of the stroke and zero at mid-stroke. The gravity cam gives constant acceleration from the starting point up to half-stroke, followed by constant deceleration to the finishing point of the movement. There are in addition all sorts of combination curves for cams, giving variable or constant velocities to the reciprocating part between selected points.

When a folding movement is traveling with unvarying speed the force required to maintain it is merely that needed to overcome frictional resistances. The force to be applied to change the speed of movement depends upon

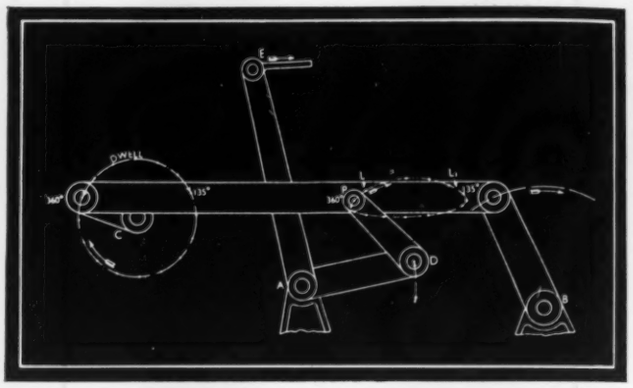
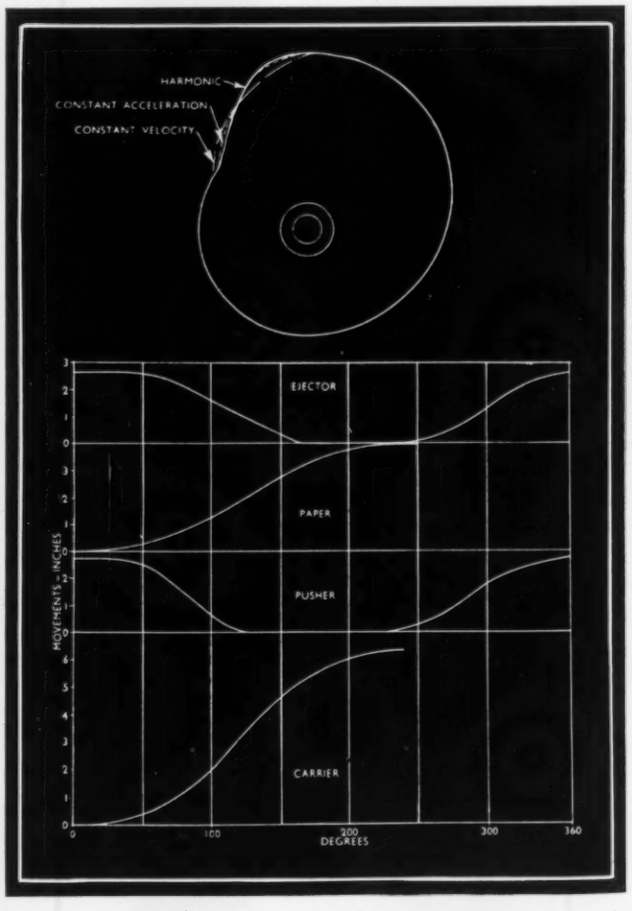


Fig. 2—This crank-driven motion is arranged to give a to-and-fro straight line traverse

Fig. 3—Plotting of the machine elements on a chart insures accurate design of details



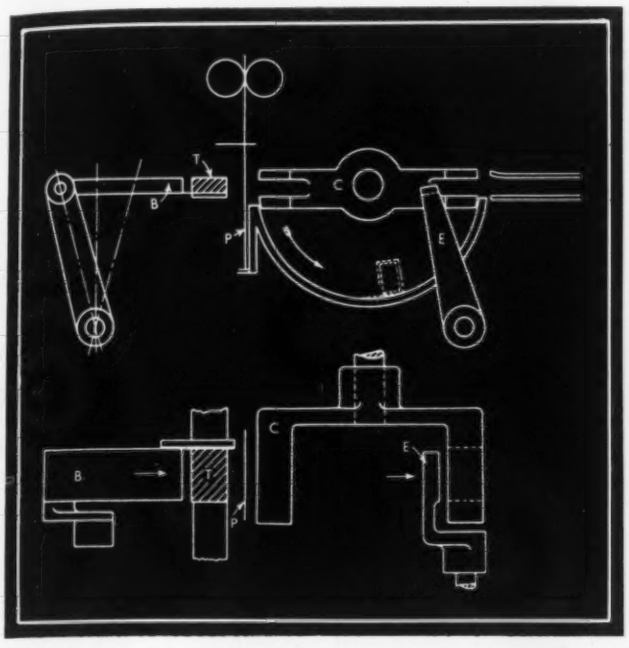
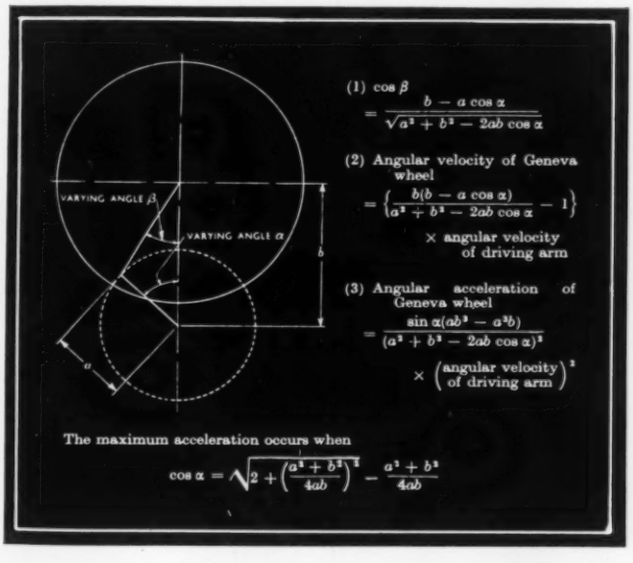


Fig. 4—Movement of the carrier folds the paper around the piece being wrapped

Fig. 5—Intermittent rotary motions of positive action are best achieved by the use of geneva mechanisms


VARYING ANGLE β
VARYING ANGLE α
b
a
(1) cos β
= (b − a cos α) / √(a² + b² − 2ab cos α)
(2) Angular velocity of Geneva wheel
= {b(b − a cos α) / (a² + b² − 2ab cos α) − 1}
× angular velocity of driving arm
(3) Angular acceleration of Geneva wheel
= sin α(ab³ − a³b) / (a² + b² − 2ab cos α)²
× (angular velocity of driving arm)²
The maximum acceleration occurs when
cos α = √(2 + ((a² + b²)/4ab)²) − (a² + b²)/4ab

the rate of change and the weight of the part moved, and the question arises whether these changes should be impressed upon the reciprocating part by making the relevent arc of the cam according to the harmonic curve or the so-called gravity curve. The latter form is preferable for two reasons. In the first place the driving force is uniform because of the constant acceleration throughout the period of change, and secondly the greatest force exerted at the beginning of the movement by the harmonic cam is between 10 and 11 per cent in excess of the uniform force exerted by the gravity cam. This means that in the long run the harmonic cam would develop a local wear 11 per cent in excess of the uniform wear of the gravity cam.

In allocating the times allowable for all the movements of a machine the principle already indicated may be applied to groups of associate motions with the object of usefully distributing the periods so that no one movement is unnecessarily violent. It must be remembered that when one speaks of the movement of a part one refers to the movement of its mass center and since this may not be accurately determinable from drawings it may not be possible to realize fully the ideal condition, though awareness of the theoretical principles involved will undoubtedly be of assistance.

Should Plot Movements

As soon as the main movements in a machine have been provisionally determined they should be plotted on a chart, *Fig.* 3. The horizontal base of this chart should represent a machine cycle in degrees of arc, and vertical measurements in inches should represent the position of each moving part at all points in the cycle. For a given speed of working the horizontal base represents time to a determinable scale. Consequently the slope of the movement curves on the chart will represent the velocities of the moving elements at any point chosen for examination. From the movement chart a velocity chart can be constructed. Similarly the various slopes on the velocity charts can be plotted to give an acceleration chart. In this way an analytical picture of the working is obtained, which may profitably be studied by the designing staff. Apart from mere questions of mechanical clearances of the movements the charts enable improvements to be effected in the dynamic interaction of the mechanisms, and details can be modified as the whole design proceeds.

Cams Indexed from Charts

The elements referred to in *Fig.* 3 are illustrated in *Fig.* 4 in elevation and plan. *T* is the tablet to be wrapped; the bar *B* pushes the tablet against the paper *P* into the jaw formed on the carrier *C*. The paper is partially folded on entering the jaw, and the movement of the carrier folds the paper as illustrated in the intermediate position. When the tablet is pushed from the carrier it is entirely enclosed in a tubular wrapper with the ends open. The chart deals with these four movements. It will be noted that the carrier completes its movement in about 240 degrees of the cycle of 360 degrees. As the carrier comes to rest the tablet is pushed over from the feed belt into the jaws of the carrier. At the same time the ejector *E* passes through the other pair of carrier jaws and dwells in a position clear of the jaws. As the jaws rotate

the ejector passes between the two pairs of jaws when they are approaching and passing by the vertical center line. The paper begins to move downward slowly until the pusher bar *B* is drawn back from the path of the paper. From such charts the cams are all indexed and the correct timing is obtained by erecting to the index marks.

Reference has been made to a crank-driven motion arranged to give a to-and-fro straight line traverse with a considerable dwell period at one end of the stroke. In *Fig.* 2, *C* is a shaft rotating at constant speed. *A* and *B* are fixed fulcrum pins. The point *P* is chosen on the connecting rod with reference to the shape of the locus of its path. Having determined this, a link *PD* is chosen of such a length that when it swings on the pin *D* its upper end will, within certain limits, describe a path coincident with the locus of the fixed point on the connecting rod. A slider attached at *E* will, therefore, reciprocate horizontally, but the slider will be stationary between the points LL_1.

Movement Is Interesting

Some ingenious wrapping machines have been made using this type of gear instead of cams, and it has been claimed that they are superior because they are quieter and are less liable to inaccuracy of movement due to wear. It seems to the author, however, that given equally good workmanship and material a positive cam action having three or four less joints would develop less "slogger" than the linkage described.

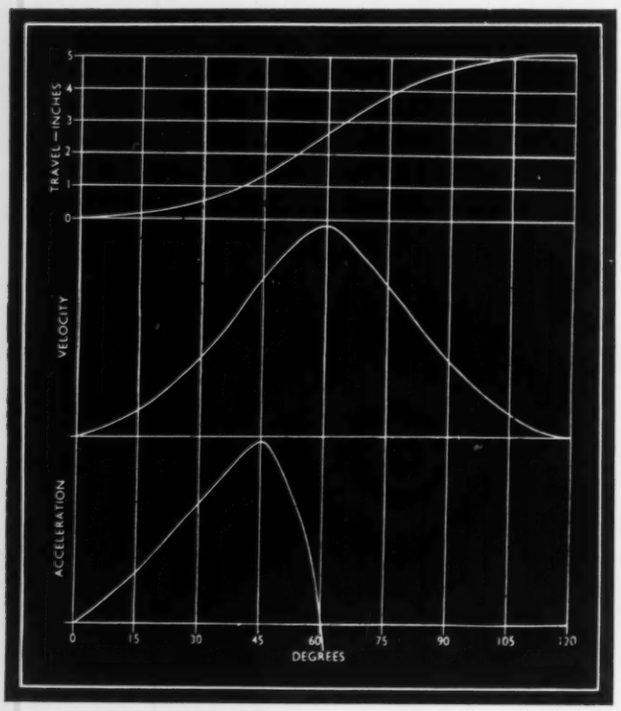


Fig. 6—Where geneva gears are of frequent application office charts simplify design steps

Nevertheless the movement is interesting and may, in the exigencies of design, find a useful place even in a cam-driven machine.

Turning now to intermittent rotary motions of positive action, that is to say movements that do not allow the driven member to overthrow in consequence of its momentum as with the ordinary pawl and ratchet, the commonest example is the well-known geneva motion. Where such gears are of frequent application it is useful to prepare office charts giving the motion of the driven wheel in terms of the angular movements of the driving shaft so that at every position the movements can be plotted on the general timing chart of a particular machine. The formulas given in *Fig.* 5 will suffice for plotting these charts, which are shown in *Fig.* 6. The point of maximum acceleration, which is also the point of maximum effort and consequently the point of maximum wear, occurs somewhere between a fourth and a third of the distance from the outside of the slots in the driven wheel. The exact position is given by the formula. On examining old geneva wheels the slots will always be found to be a little wider due to wear.

Gearwheel Is Not Concentric

Another less well-known movement for altering the angular velocity of a driven shaft is shown in *Fig.* 7. The shaft *O* has a gearwheel *D* mounted upon it which is not concentric with the shaft center. Shaft *A* is the driven member. The connection between them is effected by means of an idler wheel *B* floating on a radius link connecting *A* and *B* and connected to the center of the offset wheel on *O* by another link. The idler is therefore held in mesh with the wheels on shafts *A* and *D*.

As *O* rotates the radius link rocks and is at one period traveling round the center *O* in the same direction as *A* is turning. At another period the link is traveling in the opposite direction. As a result of this differential movement the shaft *A* is accelerated and retarded.

Wheel Governs Variation

The amount of this variation is governed by the eccentricity of the wheel on shaft *O* and this may be increased to such extent that the shaft *A* can be made to reverse its rotation for a part of its cyclic movement. An offset radius can be determined by graphic construction with any given size of wheels insuring that at a certain time the shaft *A* will come to rest. Theoretically it can only be at rest instantaneously, but the approach and departure from the rest positions is relatively so slow that the apparent dwell on a mechanism driven with this gear will be about 60 degrees of the cycle of revolution of the driving shaft *O*. By giving a very

slightly greater offset to the gear on *O* an imperceptible backward movement may be given to *A* which will increase the apparent dwell to over 75 degrees. To reproduce the actual movements of this apparatus on the machine timing chart, it is necessary to plot first a velocity diagram, which is easily done by graphic construction. The total area of this diagram will represent the total movement of the driven member to some determinable scale. By taking the areas up to successive ordinates on the velocity chart the actual movements at each successive ordinate can be plotted.

One more method of coupling rotary motions so that a variable speed may be given to the driven shaft may be mentioned. In connection with revolving cutters it is sometimes desirable to adjust the actual speed of the cutter to the traverse of the web of paper or other material at the instant when the cutting is taking place. Instead of driving the cutter shaft by ordinary

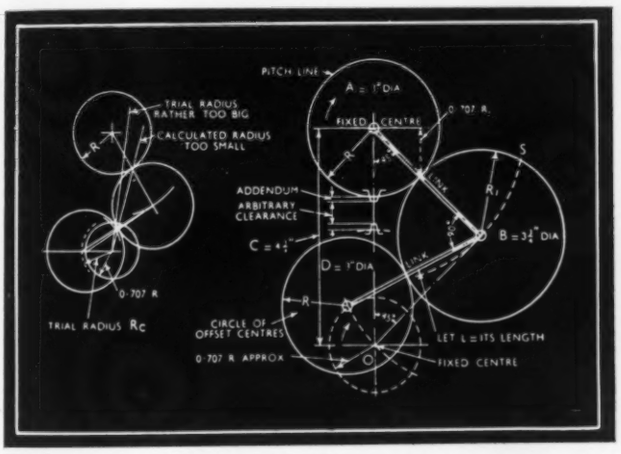


Fig. 7—Gearwheel is not concentric in mechanism for altering the angular velocity of a driven shaft

gears it is coupled through elliptically shaped gears which can be made to change the velocity ratio between the two shafts in the proportion of, say 1 to 4, by imperceptible increments. By adjustment the actual speed of cutting can be made to coincide with the traverse of the web so that no dragging takes place.

When rolls of tin and other foils became available the problem of paying out the foil from a heavy cylinder of practically solid tin had to be faced. The tensile strength of a strip of foil is small; the roll may weigh 10 pounds or more and have a comparatively large moment of inertia. The problem is how to set this mass of metal in motion by the tangential tension on the strip without breaking it. Whatever the safe tangential tension may be, its moment about the reel center gradually becomes less as the foil is used. The moment of inertia also becomes less and less. Whatever the diameter of the reel may be, the moment of inertia falls away faster than the turning moment. Hence the tangential starting effort from rest on frictionless bearings does not increase as the roll diminishes both in radius and weight.

This may be all very well when the roll is mounted on frictionless bearings, but if that were the case when once the roll was put in motion it would continue to pay out foil whether it was wanted or not. For this reason some brak-

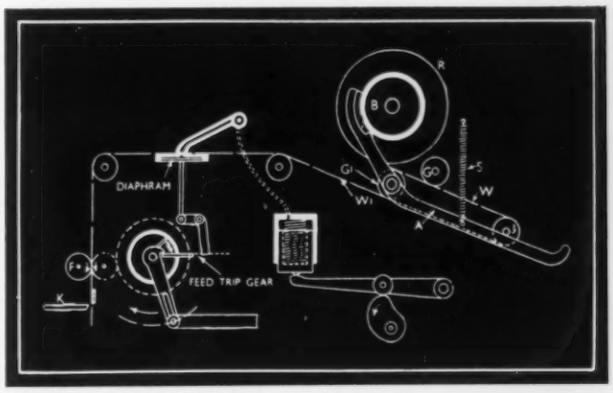


Fig. 8—Roll tensioning device makes use of a jockey which rides on the central lever

ing action is required which will increase if the roll pays out too much, and diminish if it pays out too little. Moreover, the braking action must be controlled so that the tension on the web of foil is to all intents and purposes constant and well within the breaking stress. The major factors in the problem appear to be (1) that the tension on the web must be relatively small, (2) that the foil reel should be mounted on bearings as frictionless as possible, (3) that a variable brake should act on the foil spindle so that the restraint shall weaken as the turning moment diminishes, and (4) that the regulation of the brake pressure should depend entirely upon the amount of web paid out at any particular time.

Jockey Controls Tension

In *Fig.* 8, *R* is the foil reel on ball bearings, *G* is a guide roller so placed that the web of foil *W* is parallel with the return portion W_1; the spindle of another guide roller carries a freely pivoted pair of inclined arms *A*, rigidly connected together a few inches apart, the top end acting as the brake arm. A pair of intermittently operated feed rollers *F* carry the foil forward step by step and at each pause the knife *K* severs the web. The arms *A* are counterbalanced by an adjustable tension spring *S*. A brake drum *B* is keyed to the foil spindle. The web passes round the jockey roller *J* which rests on the arm *A*. Tension of the spring *S* is adjusted so that when *J* is close to the bottom

(*Concluded on page* 90)

Scanning the Field . . . FOR IDEAS

NO LESS a personage than Robert G. Ingersoll wrote these lines: "The progress of the world depends upon the men who walk in the fresh furrows; upon those whose faces are radiant with the glare of furnace fires; upon the delvers in mines, and the workers in shops; upon those who invent and discover; upon those who dare to pioneer, sponsor or promote; upon those who lead rather than follow."

Although somewhat rhetorical, there is much in that quotation to inspire thought. It glorifies the designer, to whom these columns offer basic ideas upon which to build other ideas that will promote further mechanical progress. Leadership, a fundamental necessity in every worthwhile design project, is encouraged. The world eagerly awaits those new developments which engineers with vision will continue to produce.

SPEED DIFFERENTIAL GIVES WEIGHT

HOW the changing diameter of a cone has been employed in the development of a conveyor scale, *Fig.* 1, for continuous weighing affords an interesting example of the utilization of an idea. The integrating mechanism consists of this cone and a rotating switch driven by a flexible shaft geared to one of the conveyor belt drums, an integrating wheel mounted on a hollow shaft and driven by the cone, and a reversible motor with a pinion gear that engages a rack which raises or lowers the integrating wheel on the face of the cone.

Integration of weight is effected by the differential in speeds between the integrating wheel rotated by the cone, which depends upon its vertical position on the cone, and the rotating switch which rotates in the same direction, but in unison with the speed of the cone. When there is no load on the conveyor belt and the scale is in balance, the integrating wheel rotates on a diameter of the cone which is exactly the same as that of the integrating wheel. Thus no differential is effected.

As the load comes on to the section of the belt borne by the scale, the beam, the tip of which terminates between two electric contacts, rises until it closes the circuit at the upper contact. This starts the reversible motor, raising the integrating wheel on the face of the cone and increasing its speed above that of the rotating switch which remains constant and in unison with the speed of the cone. The scale beam, being sensitive, responds quickly to any variation in the load, contacting in either direction to cause the reversible motor to shift the integrating wheel to a position on the face of the cone where its speed will be proportional

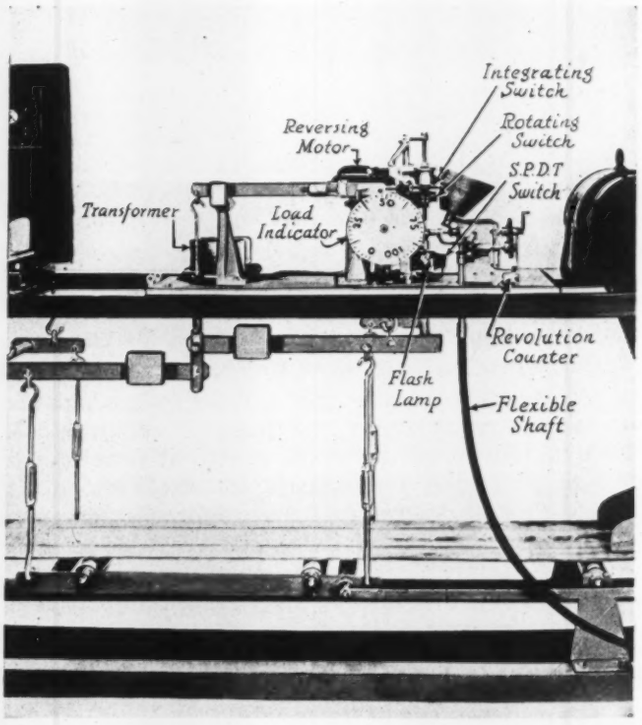


Fig. 1—*Material is weighed while in transit on a belt conveyor by an ingenious integrating mechanism*

to the load on the scale.

A wheel having a series of cams around its periphery is an integral part of the integrating wheel. The rotating switch is provided with a cam lever. They are so located that if the speed of the integrating wheel is greater than that of the switch, the cam lever is actuated to make and break contact, producing electrical impulses at a frequency proportional to the difference in speed between the two. Each impulse represents a unit of weight. Totalization is effected by an escapement movement similar to that used in stock tickers, geared to a tonnage register. Fairbanks, Morse & Co. engineers developed the scale.

HYDRAULICS AIDS COMPACTNESS

HYDRAULICS gives the designer a wide selection of ideas to incorporate into machines. In the case of the new Hayward electro-hydraulic clamshell bucket, *Fig.* 2, for instance, it has been possible to design this as a self-contained unit with the result that the unit virtually becomes a machine in itself. No

Fig. 2—A motor-driven fluid pump controlling an hydraulic ram effects the opening and closing of this clamshell bucket

closing line on winding drums are required. This mechanical advancement was attained by the use of a motor-driven fluid pump that actuates an hydraulic ram. Opening and closing of the bucket is accomplished through an electrical control in the operator's cab. Because hydraulic and electrical devices can be conveniently and also effectively combined, the designer can readily consider control from a remote point.

TOOL CARRIER MOVED BY AIR

COMPRESSED air, already with an impressive record in design, continues to offer increasing possibilities. One of the more recent applications involves the use of an air cylinder on a lathe to move the tool carrier forward and return it to loading position after the machining operation has been completed. This automatic machine, *Fig.* 3, is employed to turn a grease retainer groove in the bore of a ball bearing race.

Work is held in an air-operated collet con-

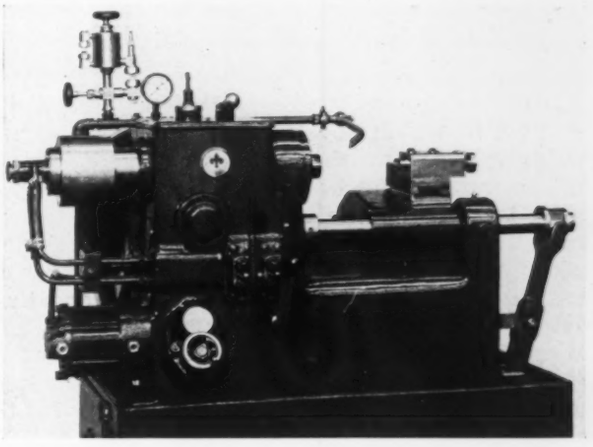


Fig. 3—Pneumatic cylinder is employed to actuate the tool carrier of the lathe

trolled by a small handle. The spindle drive is from a variable speed unit. Cross feed drive is taken off the clutch shaft. The feed is engaged by the tool slide being brought up to working position by the air cylinder arrangement. A feed cam is carried in the tool arm and engages a clutch in the headstock, providing about one-eight inch cross feed. When the groove has been turned in the work, the tool slide drops clear of the work, after which the cam trips a trigger to reverse the air cylinder mechanism which puts the slide in loading position.

This 11-inch special lathe was developed by R. K. LeBlond Machine Tool Co., Cincinnati.

MAKING THE CONVEYOR VERSATILE

CONVEYOR lines designed to meet the requirements of modern production demands afford another source of as well as a place for unique ideas. No longer can they be considered a simple series of rollers upon which material is carried by gravity or otherwise. Not only do such innovations as the Mathews coil ending device, *Fig.* 4, stimulate other ideas but they offer the designer an opportunity to employ his ingenuity in adapting these mechanisms to projects he may be engaged in laying out.

The device under discussion, incorporated in a conveyor line, receives coils of strip steel, changes them from a position in which the core axis is vertical to a position where the axis is

horizontal. It will be noted that the receiving section of the cradle arrangement has troughed rollers to handle the coils in horizontal position. A similar device has been developed by the company to discharge the coils at right angle on to another conveyor line. In this design the centerlines of the receiving and discharge sections are of course, positioned at 90 degrees to each other.

SEIZE NEW OPPORTUNITIES!

BECAUSE an engineer is not identified with a field in which developments seem to be particularly lively at the moment does not mean that he must stand helplessly by with no opportunity to share in the activity. Air conditioning came along, for instance, and many designers looked avidly at the possibilities. Some got directly into it; others started to devise auxiliary equipment such as the new Harnischfeger semiautomatic motor generator set. A fleet of 21 of these portable units is employed for precooling air-conditioned passenger cars in the union depot in Washington. They charge the batteries and serve as an auxiliary power supply to operate refrigerating units while the cars are at a standstill.

ELIMINATING VALVE NOISE

ELIMINATION of noise and impact, one of the greatest causes of valve breakage, has been attained in a new development in valve design. Conceived by Ingersoll-Rand, this new idea involves the use of channels as depicted in *Fig.* 5. The innovation is embodied in such

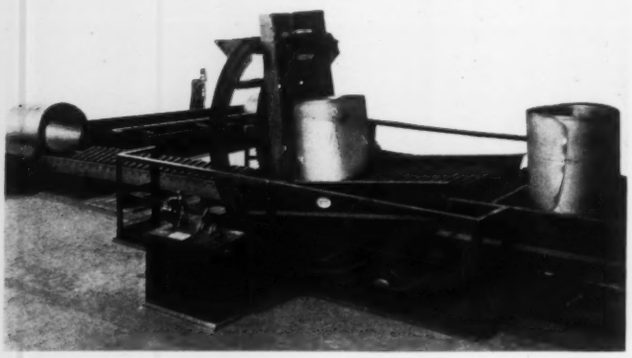


Fig. 4—*Coil upending device changes position of stock on conveyor to facilitate handling*

machines as air and gas compressors. Only moving parts are a number of valve channel pieces within each of which is a flat spring that fits snugly within the channel, so that when the valve lifts the spring straightens and a small quantity of air is trapped between the spring and the channel. Thus is formed an air cushion that functions to decelerate the valve

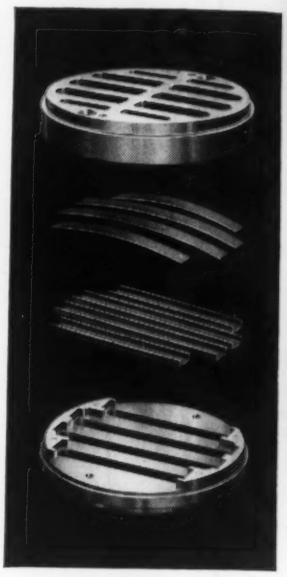


Fig. 5—*Channel valve embodies idea that eliminates impact by means of an air cushion, thus assuring silent operation. Springs and channel sections are of stainless steel*

channel after opening and bring it to a quiet stop without impact. The idea permits lightweight channels, and the springs, because they are not called upon to act as valves, are designed solely as springs.

The high speed camera does it again, this time revealing facts about explosions in internal combustion engine cylinders that had never been verified. The camera, geared, to the crankshaft, photographs through a quartz window, twenty pictures of each explosion that last a two hundred and fiftieth part of a second. The explosion starts in the region of the spark plug, and spreads in a wave like a grass fire. Temperature of the spark plug region rises to 5200 degrees. Results of the complete investigation will undoubtedly have a sweeping influence on design.

♦ ♦ ♦

This note on the high speed camera with its possibilities incites reference to another development, that comes from Hungary, which also augurs change. It is a phonograph that employs film with sound tracks instead of records. Several selections can be pieced together for continuous operation, eliminating any changing of records.

♦ ♦ ♦

Arc welded steel construction has made possible a new diesel engine that is reported to be twice as powerful yet no larger than its predecessor which it replaces in a British motorship. Welding equipment built by Lincoln in this country was employed. The new engine develops 4400 brake horsepower and is of the double-acting, two-stroke four-cylinder type.

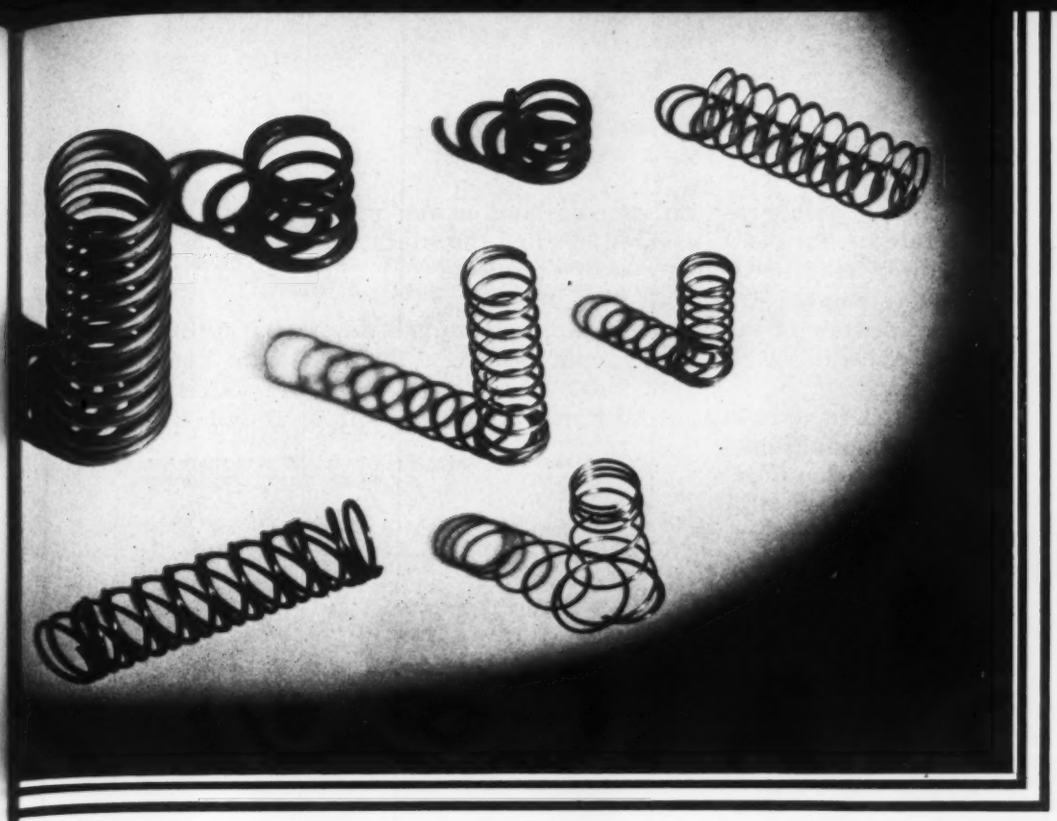


Fig. 1—Beryllium copper alloys are being utilized for springs of various sizes, particularly of the helical type

Beryllium Copper Springs Require Modified Design

By Louis L. Stott

TO those designers who need information on designing helical springs of beryllium copper, this treatise by Louis L. Stott, Beryllium Corp. of Pennsylvania, Reading, Pa., will be extremely helpful. Much of the data has heretofore been unobtainable in print.

SEVERAL copper base alloys have been developed recently in which desirable spring properties are obtained by precipitation-hardening heat treatment. These alloys combine physical properties of steel with the corrosion resistance and conductivity of bronze. And, since the materials can be given the desirable spring properties after forming, entirely new possibilities in design are available.

Of the various heat-treatable copper alloys, the best combination of strength, corrosion resistance and electrical conductivity is found in beryllium copper. This alloy containing 2¼ per cent beryllium can be heat treated to a tensile strength of 190,000 pounds per square inch or higher, and has an endurance strength of 40,000 pounds per square inch, when heat treated for high fatigue strength. Electrical conductivity depends on the heat treatment used, and can be made higher than 30 per cent that of pure copper.

In heat treating beryllium copper springs, both the elastic limit and the hardness increase rapidly during initial stages of the heat treatment. With continued time at temperature, hardness gradually reaches a maximum, and

then decreases with continued time at temperature as shown by *Fig.* 2. The rate of hardness increase is much slower with lower heat treating temperatures, and at any given temperature depends also on the amount of cold work in the material, the method of heating, and the beryllium content.

Since the heat treatment required to harden beryllium copper springs affects other physical properties as well as hardness, conventional design methods used on springs of other types of materials must be modified somewhat in designing beryllium copper springs. Any type of spring made from wire, strip or sheet beryllium copper must be completely formed into shape before heat treatment. No adjustments can be made thereafter.

In helical springs the coil diameter decreases slightly during heat treatment. In a typical example, during treatment at 550 degrees Fahr. for 1½ hours, a spring 0.500 inch in diameter decreased to 0.491 inch. This change is accompanied by an equivalent increase in the number of coils. Since this slight change varies considerably with heat treating conditions, it is usually best to determine the amount of change on a trial heat treatment.

After removing the springs from the heat treating bath, they can be cooled as rapidly or as slowly as desired; springs can be quenched in

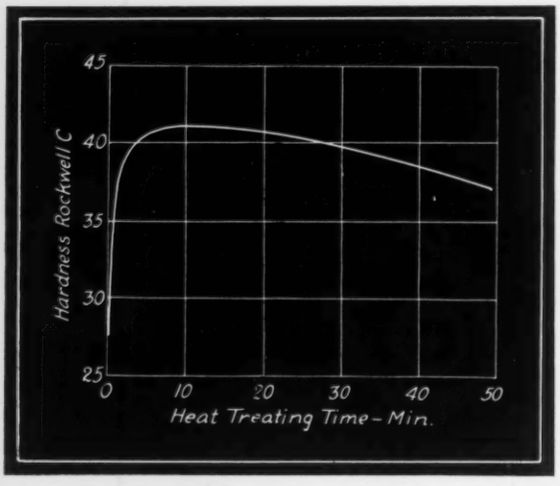


Fig. 2—Effect of heat treating temperature on time required to reach maximum hardness for a typical beryllium copper spring material. Heated in salt bath at 650 degrees Fahr.

water or cooled in air without affecting the spring properties or dimensions in any way.

At the heat treating temperature, beryllium copper has but little strength and for this reason springs must be supported or held in shape to prevent sag during the hardening treatment. Springs cannot be made with backwind or initial tension. Although this circumstance may at times cause inconvenience, it has the outstanding advantage of automatically relieving internal stresses and strains set up in forming. Heat treated springs therefore are free from the setting or creep effects found in other spring materials.

To obtain maximum strength the spring material should be given the maximum amount of cold work or spring temper permitted by the forming operation. It will be found, however,

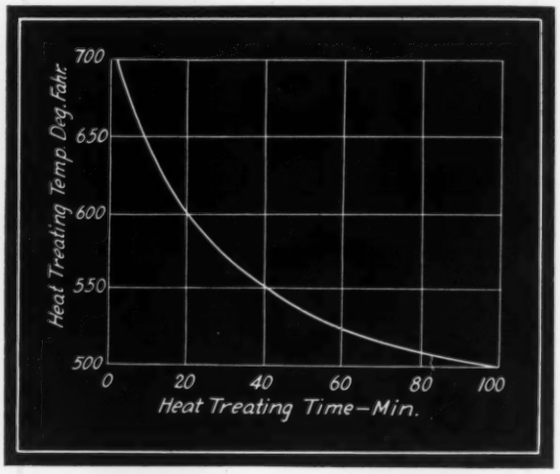


Fig. 3—Effect of continued heat treatment on hardness of beryllium copper cold worked two B & S numbers. Heated in salt bath

that beryllium copper work hardens more rapidly than phosphor bronze. A spring temper corresponding to 6 or 8 numbers hard in bronze is obtained with only 3 or 4 numbers reduction in beryllium copper. In the full hard condition before heat treatment, beryllium copper works about the same as spring temper phosphor bronze.

The same maximum hardness in beryllium copper is obtained by heat treating at any temperature from 500 to 650 degrees Fahr. but the length of time required depends on the amount of previous cold work as well as the temperature used. At a temperature of 525 degrees Fahr. about 1½ hours time is required for material with 2 to 4 B & S numbers reduction in area. At 650 degrees Fahr. the same hardness will be obtained in 10 to 15 minutes. Between these two extremes the time required is shown in *Fig.* 3. The actual time temperature needed depends also upon the size and thickness of the stock. Trial heats are usually required to determine when the hardness increase has reached a maximum.

Other properties in addition to hardness increase during heat treatment. For a heat treatment resulting in maximum hardness, tensile strength increases about 50 per cent, reduction in area becomes about 1 or 2 per cent, and the elastic modulus or stiffness also increases about 15 to 20 per cent. Electrical conductivity before heat treatment is about 18 per cent of that for copper, while after heat treatment conductivity becomes 25 to 30 or higher depending on

the time and temperature of treatment.

The increase in elastic modulus of beryllium copper during the heat treatment makes helical springs stiffer, resulting in a decrease in measured spring deflection under the same load. For example, in a spring with a load deflection rate of 10 pounds per inch after heat treatment, the load deflection rate before heat treatment will be about 8 pounds per inch. During heat treatment at 550 degrees Fahr. the deflection rate for this spring will increase from 8 to about 9 pounds per inch during the first 15 minutes at temperature. The remainder of the increase will take place slowly during the next 45 minutes. If the temperature is held for another hour, the spring will continue to increase in stiffness but the change will be small.

Several simplified methods of designing helical tension or compression springs have been introduced. All of these methods are based on the following fundamental relations which have been determined by mathematical analysis and checked experimentally. For helical springs wound from round wire, the deflection f in inches per active coil increases directly with the load P in pound, and the cube of the mean coil diameter D; the deflection per active coil increases inversely with the torsional modulus G of the spring material, and the fourth power of the wire diameter d. Expressed as an equation:

$$f = \frac{8 P D^3}{G d^4} \quad \text{.....(1)}$$

For a given load or tension and a given spring material, the desired deflection per active coil depends only on the combination of mean coil diameter and the wire diameter. The wire diameter is, of course, standardized so that the final adjustment must be made in the coil diameter or in the number of active coils.

Usually, several combinations of mean coil diameter and wire size can be found that give the required deflection rate. A coil diameter about eight times the wire diameter usually gives a balanced design, although a larger coil diameter may be desirable to reduce working stress.

When a satisfactory combination of mean coil diameter and wire size is found, the design is then checked for working stress, which is given by S in pounds per square inch in the following equation after substituting the load in pounds, the mean coil diameter and the wire size.

$$S = \frac{8 P D}{d^3} \quad \text{.....(2)}$$

Safe working stresses depend on the type of service and the degree of stability desired. Where deflection rate or calibration must remain constant as in instrument springs, low working stresses must be used, and the heat treated spring must be protected against possible overstress which would cause change in calibration. For stable springs, working stresses should not exceed 35,000 pounds per square inch. However, stresses of 50,000 to 60,000 pounds per square inch can be used where stability requirements are not severe.

For springs in which permanent deformation or breakage is the only limiting factor, the elastic limit can be increased to 100,000 pounds per square inch in smaller wire sizes by "surging" or overstressing the spring following the practice commonly used for steel springs. For steady loads, working stresses up to the elastic limit can be used. For rapidly fluctuating loads, however, fatigue failure limits working stresses to about 40,000 pounds per square inch if the possible number of load cycles is one million or more.

If the stress calculated from the formula is too high, a larger wire diameter must be used in equation (1), and a new coil diameter found that gives a safe working stress.

Any change in design that requires more material will be found to reduce working stress. By increasing the wire diameter or the number of active turns, working stress will be decreased. For a given solid spring length, the number of turns depends on the wire diameter. If the maximum coil diameter that is permitted by space restrictions still gives too high a stress, a longer spring with a larger number of active coils must be used. In compression springs about one coil on each end is not active, and these coils must be substracted from the total number of coils to obtain the number of active coils. In tension springs the number of dead coils varies with the type of spring end.

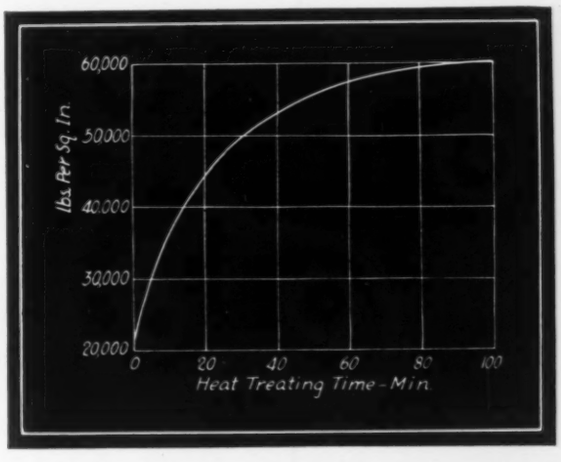


Fig. 4—Increase in torsional proportional limit for cold worked beryllium copper wire during heat treatment at 550 degrees Fahr. in salt bath

The deflection given by equation (1) depends on the value selected for the torsional modulus G. This value, as stated above, changes during the heat treatment of the beryllium copper springs. Tests on a number of springs show that

(*Concluded on page 85*)

Localized Stresses Menace E

By V. L. Maleev

Oklahoma Agricultural & Mechanical College

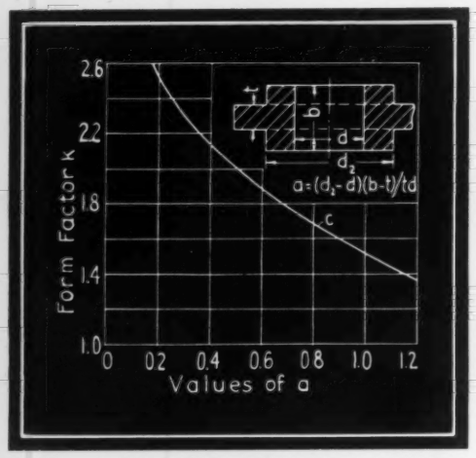


Fig. 1—Symmetrical reinforcing bead reduces influence of hole

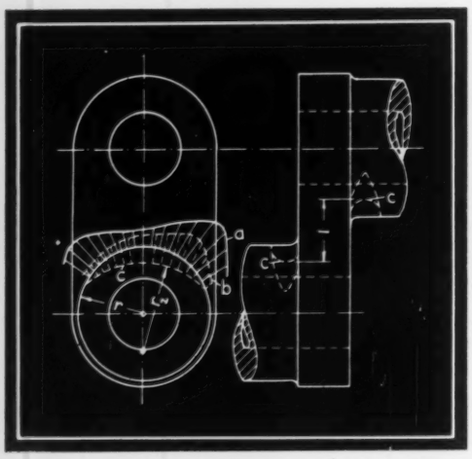


Fig. 2—Interesting method of increasing crankshaft endurance strength

THE importance of taking into account stresses in machine parts due to localized stresses was brought to the attention of machine designers in a previous series of articles by the writer[1]. These localized stresses are particularly dangerous in parts subjected to repeated loading. With this type of loading, even without any other complications, the limit stress, called the endurance limit S_{en}, of a material is considerably lower than the elastic limit S_e.

With very few exceptions, all machine parts have discontinuities which cause stress concentration. The influence of stress concentration upon the strength of parts subjected to repeated loading, for short called the endurance strength, may be presented by the ratio of the endurance limit S_{en} *without* a discontinuity to S'_{en}, the endurance limit *with* the discontinuity. This is designated by k_r or

$$k_r = S_{en}/S'_{en} \quad \ldots\ldots (1)$$

The exact magnitude of k_r for different types of stress concentration can be found only from tests. However, it has been established that k_r is a definite function of the form factor k, which expresses the theoretical influence of a discontinuity[2]. Thus any step which will lower the form factor k will lower k_r and raise the endurance strength of the part. Another method is to decrease the localized stresses by setting up stresses acting in the opposite sense.

FORM FACTOR DECREASE—The undesirable influence of a hole in a part can be decreased by a symmetrical reinforcing bead, *Fig.* 1. The reduction of the form factor k is a function of the ratio of the cross-sectional area of the bead itself, $(d_2 - d)\ (b - t)$, to the area of the diametrical section removed by the hole td. Designating this ratio by a or

$$a = (d_2 - d)\,(b - t)/td \quad \ldots\ldots (2)$$

the values of k are plotted against those of a, curve c. This curve shows that with $a = 1.2$ the form factor k can be

[1] "Avoid Waste of Material in Parts Design," MACHINE DESIGN, vol. 7, June-October, 1935.

[2] MACHINE DESIGN, vol. 7, No. 7, July, 1935, p. 22.

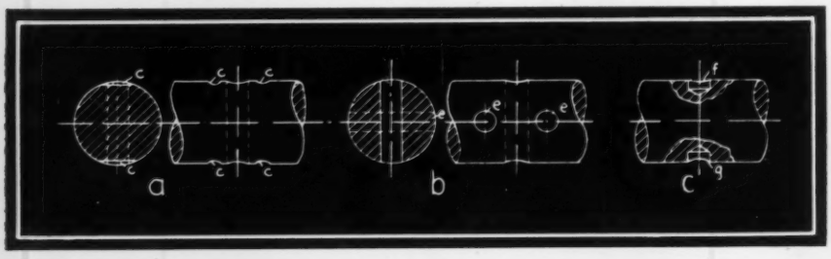


Fig. 3—Tangential notches can be used to decrease the weakening effect of a transverse hole

ace Every Design

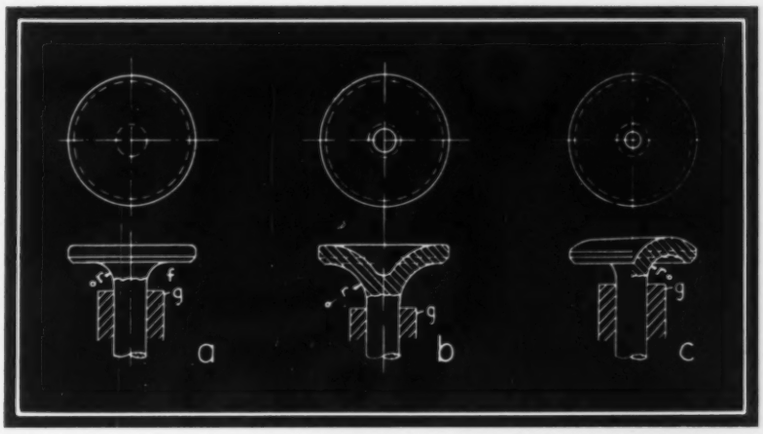


Fig. 4—Correct and incorrect shapes for resisting repeated stresses

reduced to about 1.35, or less than one-half of its maximum value of 3, when $a = 0$.[3]

HOLES—The weakening effect of a transverse hole in a shaft which is subjected to bending or torsion can be decreased by filing tangential notches *c, c* near the edge of the hole, *Fig.* 3*a*. These notches spread the stress concentration over a larger section and, by decreasing its maximum intensity, lower k and k_r by several per cent. A similar effect is obtained by drilling additional holes *e, e*, *Fig.* 3*b*.[4]

Unsymmetrical shapes always create stress concentration and should be avoided whenever possible. The endurance strength of a shaft with a radial hole *f*, *Fig.* 3*c*, can be increased by drilling another hole *g*, making a symmetrical cross section.

Should Increase Fillet Radius

FILLETS—The simplest and best way to decrease stress concentration near a fillet is to increase the radius of the fillet. *Fig.* 4*a* shows the exhaust valve of an internal-combustion engine which was breaking at *f* after a certain time of operation by progressive fracture due to a high stress concentration caused by an insufficient fillet *r*. This trouble was eliminated by increasing *r*, *Fig.* 4*b*. The material from the center of the disk was removed in order to obtain a more uniform thickness and thus to reduce still further stress concentration. *Fig.* 4*c* shows a still better solution which permits bringing the top of the guide, point *g*, nearer to the valve seat.

If a shaft fillet cannot be increased in the usual way due to the necessity of maintaining a minimum bearing length, an undercut fillet may be used, *Fig.* 5. The sketch illustrates the use of an undercut fillet in the design of a crankshaft, but it can be used also at the juncture of two greatly differing diameters of a straight shaft.

An interesting way of increasing the endurance strength of a crankshaft is shown in *Fig.* 2.[5] In this case the lowering of stress concentration is obtained by cutting eccentric circular grooves to depth *c, c*. This removes parts of the journals subjected to the highest stress and increase elastic length *l*. The torsional shear stresses which existed in the shaft originally are shown in a polar diagram by

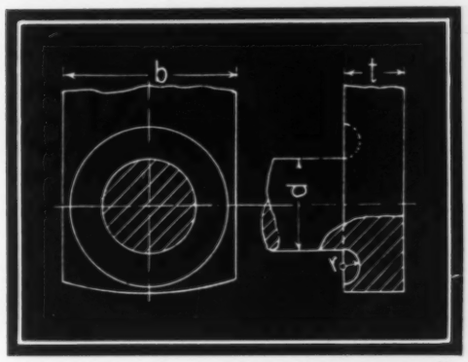
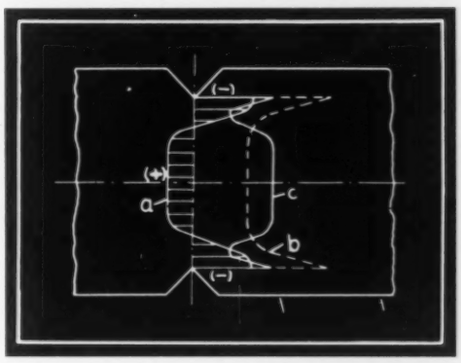


Fig. 5—Undercut as shown aids in equalizing stress loads

Fig. 6—Stress redistribution takes place after a permanent set



curve *a*, while the stresses obtained after the eccentric grooves were cut are given by the curve *b*. This method could be applied in this special case because the crankshaft was originally designed for plain bearings, and when trouble developed due to excessive stresses, the design could be changed to the use of ball bearings.

LOWERING OF LOCALIZED STRESSES—Machine parts fractured through

[3] Timoshenko, S., and W. Dietz, *Trans. A. S. M. E.*, vol. 47, 1925, p. 207.
[4] Ude, H., *Z. VDI*, vol. 79, 1935, p. 48.
[5] *Z. VDI*, vol. 76, 1932, p. 981.

repeated loading show that the fracture always starts at the point where the stress has the maximum intensity. Any provision which will lower the highest stress in the outer fibers will decrease the stress concentration factor k_r and thus increase the strength of the piece.

Thus the injurious action of notches and circular grooves in a machine part subjected to repeated loading can be decreased if the part is stretched in advance so as to produce in the groove or notch a permanent set. As a result of this pre-stretching an internal tensile stress will be set up in the center of the part which will cause a compressive stress in the outer fibers, next to the notch, curve *a*, *Fig.* 6. The stresses due to tension, curve *b*, combined with the above stresses created by a small permanent

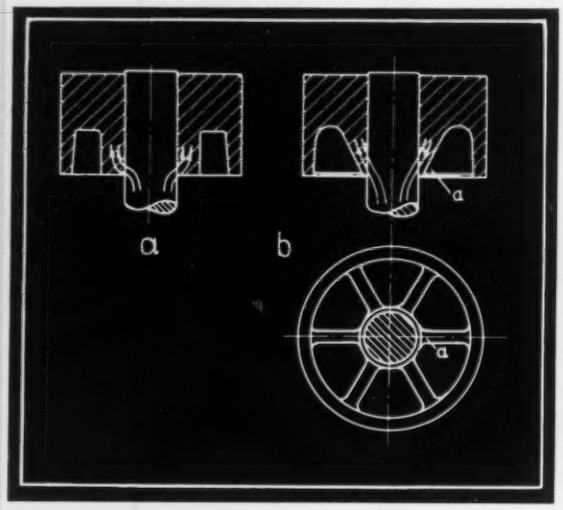


Fig. 7—Design of conical gripping part reduces shrink-fit stress concentration

set, give the resultant stress curve *c*. The general stress distribution is much more even; the maximum tensile stress near the notch is considerably reduced, and the strength of the section is materially increased.

It has been found also experimentally that tension is always the more dangerous stress than compression. Putting into the notch a plastic deformation by a local pressure will accomplish the same object. Thus, the helpful effect of equalization notches *c, c, Fig. 2a,* is considerably increased if the notches are pressed in instead of being filed[4].

Shrink-fit stress concentration can be materially reduced by making the gripping part conical, *Fig.* 7. The elasticity of material, even if it is cast iron, produces a gradually increasing shrink pressure, a more uniform force flow. As a result the stress concentration factor k_r can be reduced from 1.87 in the hub type (*a*) to 1.38 in that of (*b*). Still better results are obtained by a parabolic hub-shape, *Fig.* 8, as used in gears. Naturally, if the torque is transmitted from the gear to both ends of the shaft, the hub must be symmetrical toward both ends.

Another method of increasing the endurance strength of a shaft on which a hub is shrunk on is to put in advance a surface compressive strength in the outer fibers of the shaft by cold rolling. The stress concentration factor k_r in a shaft with such a plastic deformation ground afterward to the proper shrink dimension may be lowered to 1.07 with an ordinary hub, *Fig. 7a,* and with a conical or parabolic hub the shaft may become even stronger than the original material.

Case hardening of mild steel shafts reduces the shrink-fit stress concentration to a very small amount. Nitriding eliminates this stress concentration entirely; it also eliminates in press fits the dangerous pressure oxydation. Nitriding eliminates the stress concentration effect of notches and grooves probably by preventing the starting of minute cracks one of which, at the point of highest stress, gradually develops into a progressive fracture.

Oxydation stress concentration can be decreased considerably by grinding off the outer fibers affected by oxydation to a depth of 0.004 to 0.008 inch.

Corrosion effect upon steel is materially reduced when the part is protected by sherardizing or cadmium plating. Nitriding eliminates corrosion and its effect entirely.

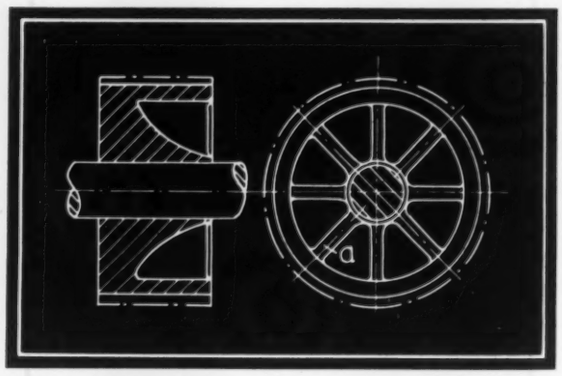


Fig. 8—Parabolic hub shape gives even better results in stress relations

The endurance limits of stainless steels are also less affected by corrosion effect.

The foregoing discussion is devoted to a great extent to shafts and to the increase of their endurance strength. This is done, first, because shafts are such an important part and a so extensively used one in all kinds of machinery and, second, because the service conditions of shafts in regard to repeated stresses, in general are much more severe than of other commonly used machine parts.

Naturally, many procedures useful in decreasing stress concentration in shafts may be applied to other machine details as well.

Gear Makers Study Welded Plus Cast Design

FOR twenty years the American Gear Manufacturers association has been promoting higher standards in the development, production and marketing of gears, that classification of machine parts in which every designer of machines has a vital interest. The annual meeting held recently in Philadelphia continued this indefatigable campaign. An impressive group of papers was presented, several of which are discussed herewith. Others will be considered in a subsequent issue of MACHINE DESIGN.

ROLLED steel plate in combination with steel castings is the most equitable choice of material for the designer, Everett Chapman, Lukenweld Inc., told A.G.M.A. members in his discussion of welded gears and gearcases. Steel being the most rigid material available, the creation of a suitable stiff construction rests entirely in the ability of the designer to apportion and distribute his various sections. Nothing, he declared, can be gained through the use of alloy steels since their modulus of elasticity is the same as that of the mild steels and the stresses for adequate rigidity generally are so low that the superior yield point of the alloy steels means nothing. The proper steels for welding are those whose carbon content is very low. To be more general, the proper steels are those whose alloy content, including carbon, is such that air hardening properties are minimized.

Of importance in the heat treatment of welded structures is the length of time necessary to stress relieve thoroughly. The conventional metallurgical criterion is one hour per inch of maximum thickness. This is not sufficient for stress relief, Mr. Chapman contended. One hour per inch of thickness is the time necessary to raise the interior of the piece to the desired temperature to produce the required metallurgical phase changes. It is necessary for adequate stress relief to increase the time that the piece is in the furnace at 1200 degrees Fahr. Pieces should be allowed to furnace cool to at least 250 degrees Fahr. and should be so protected in the furnace that differential temperature gradients are not produced as the piece is being heated.

Low Carbon Castings Recommended

Most gearcase designs benefit by the inclusion of castings in those parts of the design where the complexity legislates against a sound welding job. A bearing with complicated oil labyrinths and multiple shoulders is decidedly satisfactory in the form of a casting. Low carbon, electric furnace castings are thoroughly weldable and no trouble will be experienced in their use.

The main precaution in the use of castings in a welded structure is to keep the carbon

(*Concluded on page* 80)

Consider the Pump—Vital Factor in Machine Performance

By Allen F. Clark

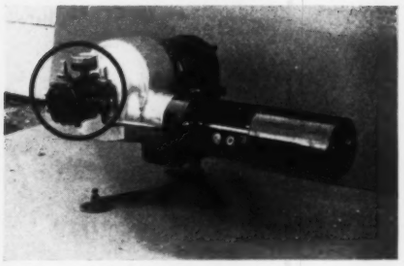


Fig. 1—Rotary pump, valves and strainer are arranged in one casting

Part II—Liquid Pumps

WHEN a designer must move a liquid through his machine there is, barring the benevolent action of the force of gravity, only one solution to his problem. He must select a pump, build it into his mechanism, preferably, and insure positive action at all times. The solution sounds very simple, but every angle of it should be the subject of careful study.

First, as noted by Ormonde Bogert in his article on air pumps in the April issue of MACHINE DESIGN, there are dozens of basic designs of pumps, and dozens of variations of these designs. As the field for many of these designs overlaps the fields of many of the others, it would be

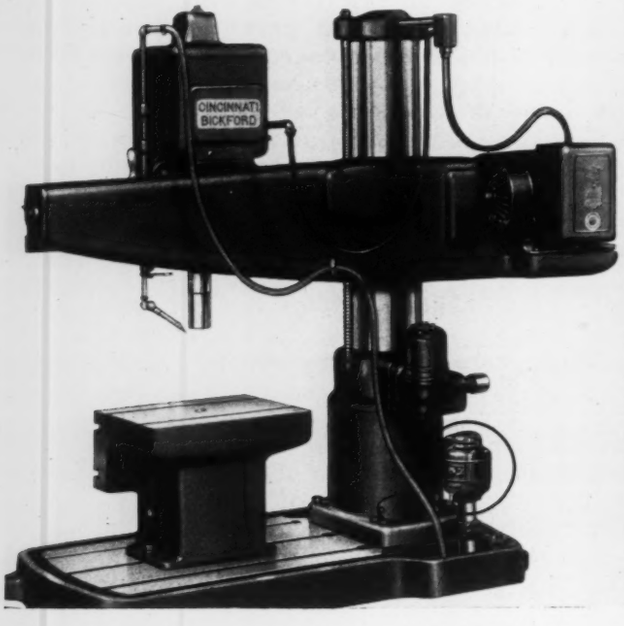


Fig. 2—A bracket cover-mounting plate is all that is necessary to include this pump in the design

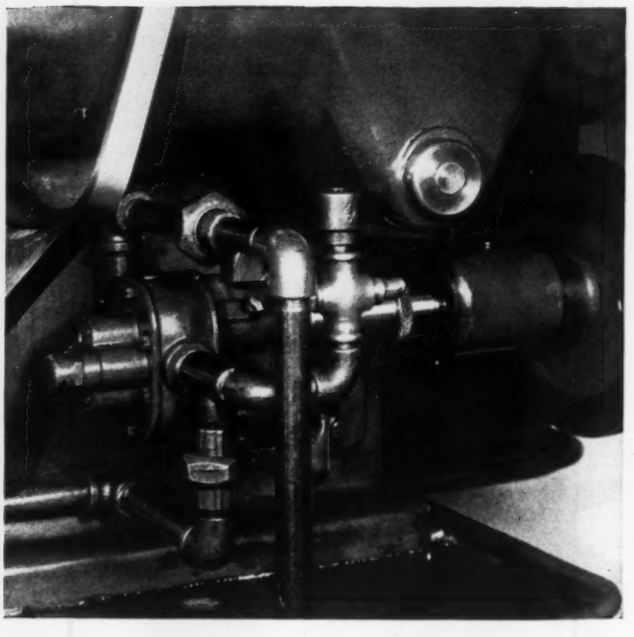


Fig. 3—Shaft-driven method is satisfactory if a constant speed shaft is available

impossible definitely to limit the selection of one type for every duty. In fact, in many cases several types of pumps are equally efficient.

The liquids which must be moved are even more numerous than the types of pumps for doing the work. Some pumps are called upon to pick up 600W petroleum products or substances with as little as 10 per cent liquid content, while others must handle extremely fluid liquids.

With this wide range of requirements it is impossible to suggest a common solution to all pump problems, but in this article we will point out basic considerations which every designer should have in mind when designing any machine that should incorporate a pump And this definition again covers a wide field, incorporating machines from the oil burner, *Fig.* 1 (one of the largest markets) which is nearly all pump, to the large mixer for blending and handling lubricating oils which includes four or more pumps and half a dozen motors, and covering machines in practically every division of industry.

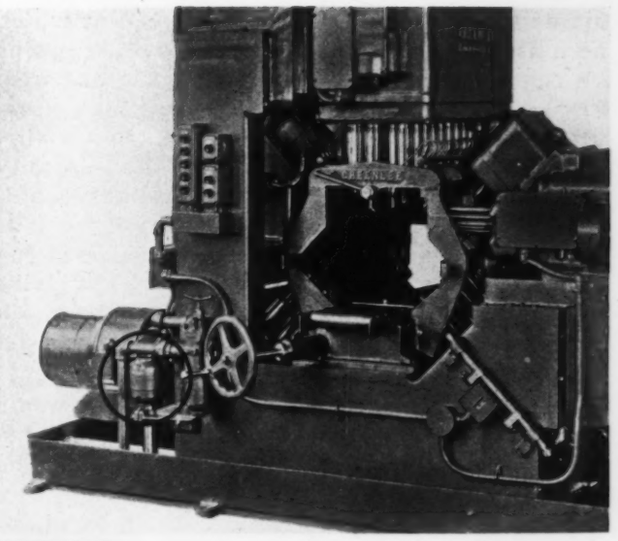


Fig. 4—An integral motorpump can be used advantageously for coolant purposes

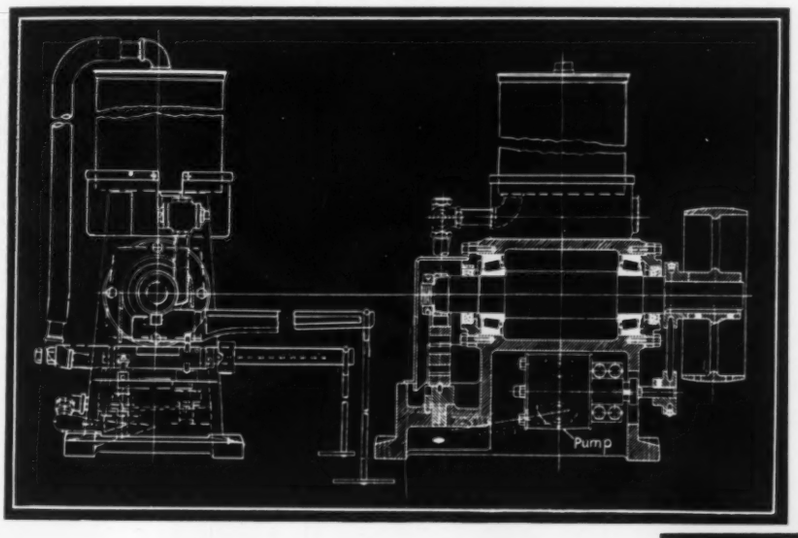
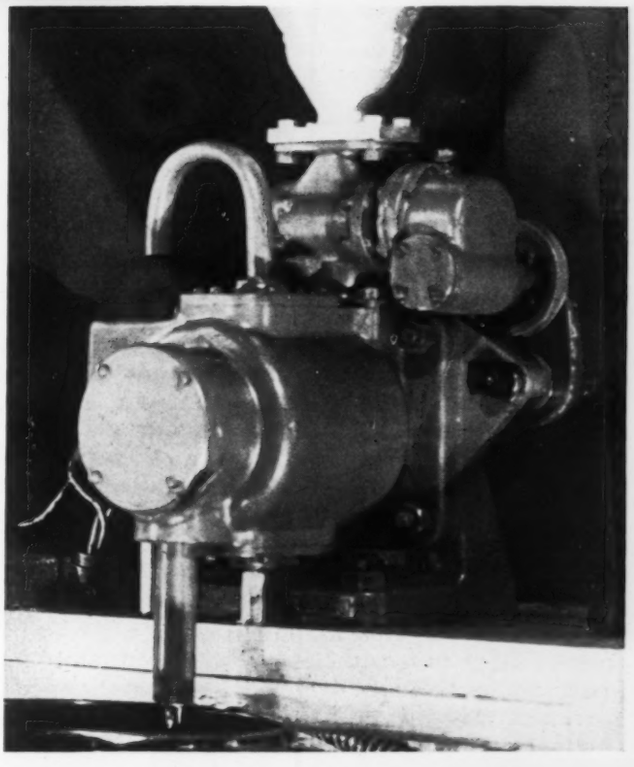


Fig. 5—Piston type pumps handles viscous liquids on this lubricant tester

Fig. 6—Paint mixing machine handles solutions that are almost a solid



The first essential consideration in the building of a pump into a design where the pump is only one of many parts in the machine is to consider the exact function of the pump in the operation of the machine as a whole. The character of service will have considerable effect on the proper selection of a pump. Hydraulic conditions must be accurately ascertained and this is best accomplished by a model which has been built based on the theoretical calculations of the hydraulic conditions. From this model the actual conditions can be determined accurately by a cut and try method so that the final machine, which would no doubt be of the production type, can be brought to the ultimate degree of simplicity and accuracy.

The type of fluid handled is, of course, very important. Specific gravity and viscosity of this fluid has a great deal to do with the proper selection of the type of pump. The viscosity of the

liquids to be handled affects the speed at which the unit may be operated. Lower pumps speeds are required for higher viscosity. Liquids with very low viscosity can be handled at high pressures less efficiently because of the greater slip. Clearances in pumps vary with the viscosity where the application is special and the conditions are known. Whether the fluid is acid or alkaline will govern the choice of material for the pump. Again, the type of control and drive is an essential feature as this has its bearing on the physical dimensions of the pumps and its mechanical construction.

There are several good ways to build a pump into the design to form an integral part of the machine. In all cases the type of drive must be considered as of first importance. Drive may be by a motor integral with the pump, by direct connection through a coupling to the motor, by shaft of the machine, or by belt, chain or gearing. A popular built-in coolant pump installation is the direct motor-driven vertical centrifugal type,

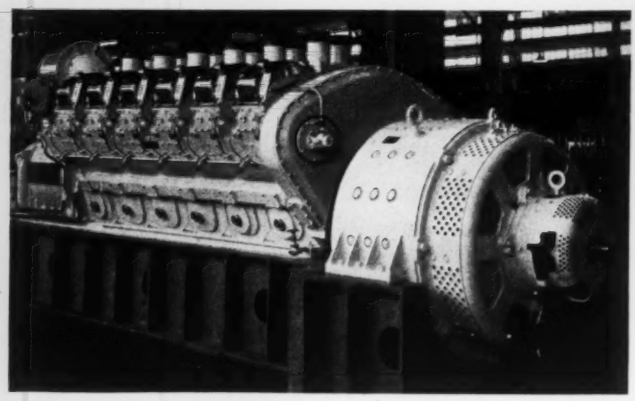


Fig. 7—Flange mountings on otherwise stock units adapt the unit for a particular machine installation

immersed at a convenient point in the coolant reservoir, with the motor alone projecting above the reservoir cover, *Fig.* 2. A bracket cover mounting plate is all that is necessary to install this type of unit.

The shaft-driven method is very satisfactory if a constant speed shaft is available. *Fig.* 3 is a good installation example of a shaft driven pump. Note the gland over the tank, outside support, and throw-out clutch. To provide such a shaft may, in some cases, exceed the cost of an entire independent motorized pump unit, so it is necessary to consider the application from this standpoint. Also, if the location of the pump is above the reservoir it must be capable of lifting, or sucking up, the liquid. A packing gland, or its equivalent, and priming might be necessary.

Belt drive is also satisfactory if a constant speed pulley is available, as in *Fig.* 6, and the same applies to chain drive with a constant speed sprocket. This driving pulley or sprocket may be vertical or horizontal. The pump in *Fig.* 6 has outside support, driving coupling, and means of priming.

The pump and associated piping should be as accessible as possible. This applies particularly to units having glands requiring occasional adjustment, and the value of such an arrangement is obvious in the case of replacement, breakdown or any other trouble. The suction lift should be kept as low as possible to give better insurance for the proper functioning of the pump, and provision should be made to take care of any leakage which may develop. This applies to pumps whether submerged or mounted just above and

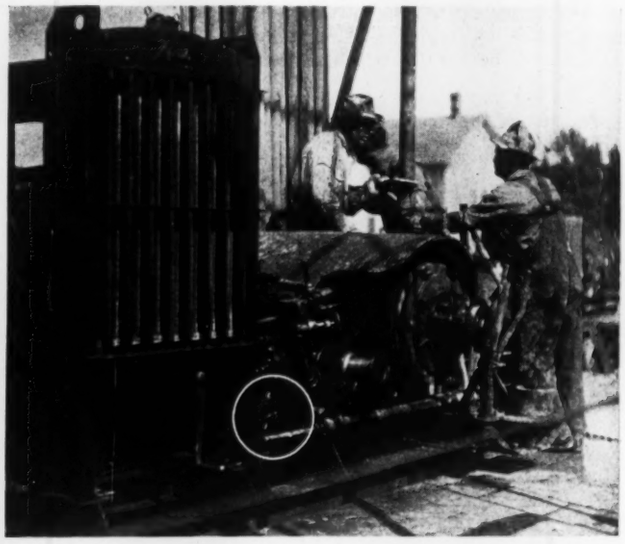


Fig. 8—Pump on this oil well drilling equipment is employed to circulate cooling water

over the liquid level in an external tank or any tank which is accesible by removal of a plate or panel. They should be so located on the main machine that they have rigid supports and are subject to the least possible vibration, or if this is not possible, the vibration must be uniform over the pumping units, not localized.

Flange Mountings Are Provided

Pumps are sometimes built into the machine itself by utilizing the machine casting as one element of the pump. Flange mountings are frequently provided on otherwise stock units, adapting the pump for a particular machine installation, as in *Fig.* 7, where the pump, used as a scavenger for removing unburned oil from the engine, is mounted directly on a diesel engine.

The pump should be so arranged that the liquid will flow to it, if possible, under a slight head, as this insures priming and eliminates the possibility of loss of pumping due to air coming in on the suction. Self-priming pumps are often useful as they maintain liquid in the pump under all conditions where the flow is not always

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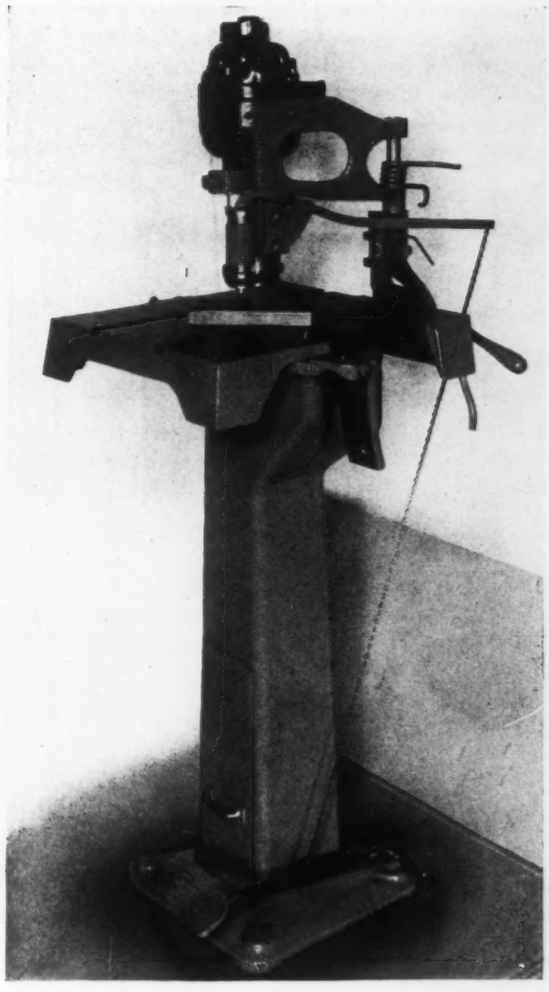
Fig. 1—Weight of motor is balanced by a spring to permit easy adjustment

Fig. 2—Entire mounting bracket can be swung around mounting post for changing of tools



Motor Mounting Expands Range of Saw Trimmer

INASMUCH as variations in purchasing power exist, and always will exist, the designer's problem often is to produce machines for each division of his field so that he has a machine for every possible purchaser that will answer the twin challenge of requirements and purse. Usually, the design of additional machines in different price ranges for doing similar work requires considerable ingenuity in order to duplicate the operation without duplicating the cost, and develops designs of considerable interest.

One such redesign, as made by J. A. Richards Co., brought out a unique flexible means of mounting the motor that permits the use of a single motor for performing a multitude of tasks. This company manufactures a universal saw trimmer for printing shops which performs three operations, namely, circular sawing and saw trimming, jig sawing or mortising and drilling or routing To accomplish these operations the machine has three motors, one for each operation. The unit does a complete and excellent job, but its price is $725, a figure which is way out of line for the medium size printer.

These companies needed a saw trimmer that would perform 90 per cent of the operations of the universal saw, do them accurately and yet

cost about half of the higher price. To accomplish this a single-motor machine was required with a motor that would be absolutely interchangeable with different voltages and current cycles, that is, the frames had to be the same size regardless of the type of current provided the user. The unit selected is a one-half horsepower, 3600 RPM synchronous type.

As the one motor must power the tools for a variety of operations, it was necessary to devise a means of mounting this motor so that it could be easily adjusted as to height and to a horizontal or vertical position. The bracket which makes this adjustment possible is shown in *Fig.* 2. In the performance of work while in a vertical position, the action is much the same as that in the usual vertical spindle, with the exception that the entire motor bracket can be swung around its mounting post to assure positioning over the correct point on the table.

For some of the operations the tools are mounted directly on the spindle as shown in *Fig.* 3, while for others requiring a faster speed, drive is from a pulley mounted on the extended motor shaft to a pulley on an auxiliary shaft of the tool, *Fig.* 2. Provision is made for the easy connection of the auxiliary parts to the mechanism.

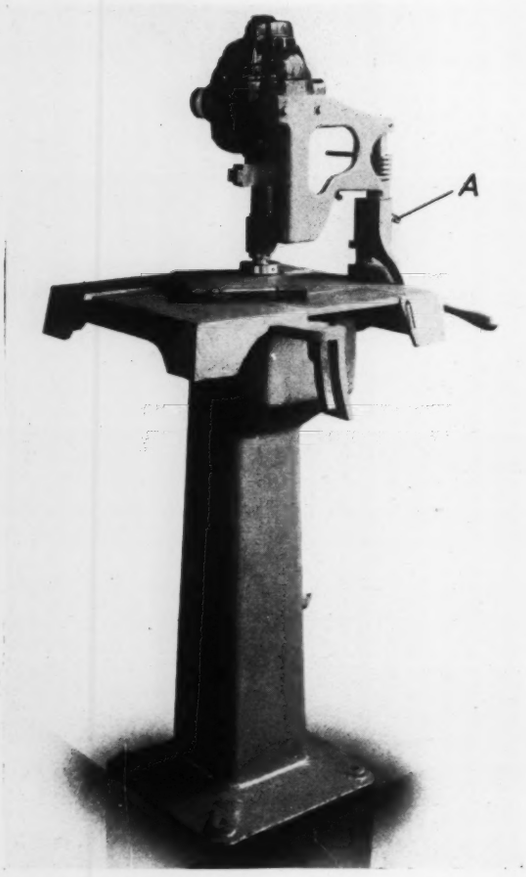
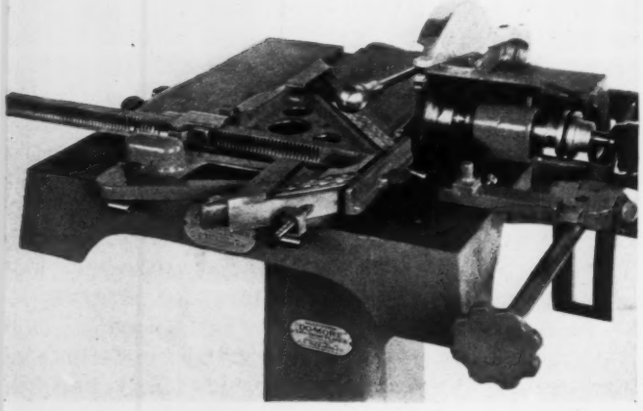


Fig. 3—*With the motor as shown, this one machine does a variety of work*

Fig. 4—*Hand lever permits adjustment in height of motor for different requirements*



Drive Must Be Horizontal

With these comparatively simple steps, the user can perform three of the many requirements for a machine of this type; that is, typhi planing, shell plate mortising, drilling and routing. There remains, however, the main operation for which the machine is used fully 75 per cent of its time, and one of extreme importance in the printing plant, circular sawing and saw-trimming. This necessitates a horizontal rather than a vertical drive.

Such an adjustment seems simple enough—just hinge the bracket at the lower end of its support and swing the motor into position. This course is followed, the two locking handles seen in *Fig.* 1 permitting the change of setting, but when the motor is in the horizontal position it is necessary to balance its weight in order to provide for easy adjustment of the saw from circular sawing to saw-trimming.

This action is accomplished by use of a spring on the bracket-supporting shaft. This spring, disconnected when the motor is in a vertical position, is attached to a lever on the rear of the bracket shaft as shown in *Fig.* 1 and in this position balances the motor by constantly providing a fixed pressure which holds it in position.

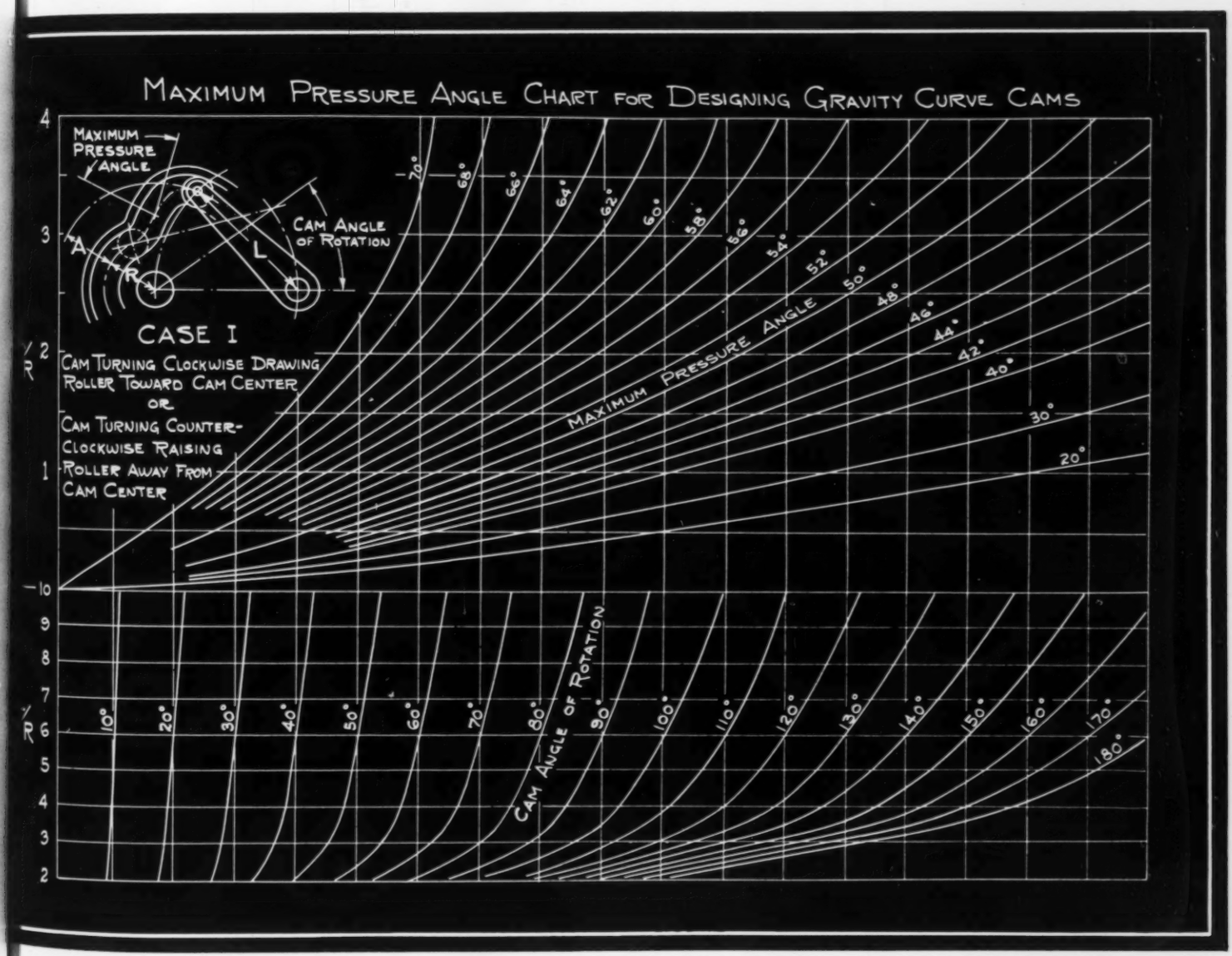
Adjustment to permit change from saw to saw trim is provided by the forward projecting hand lever in *Fig.* 4. There are two collars on this raising and lowering handle, one of which is stationary and the other loose. These are, in effect, two circular holding blocks, one being concave and the other convex. This permits the locking of the saw and motor hanger in any position on the segment of a circle, called the motor fork.

Thus design ingenuity enables the tapping of new markets by the production of an efficient machine that is economically satisfactory while giving the purchaser sufficient capacity to accommodate the individualized needs of his shop.

Cam Charts Eliminate Cut and Try Methods

By Frank Schubert

IN DESIGNING cams it is often found that in order to obtain the desired motion, cam diameter, angle of rotation, etc., the rise becomes so great as to result in too large a pressure angle. This condition can only be determined after actually making a layout of the cam track, entailing a certain amount of time and



labor. By assuming another set of conditions, the angle could be reduced, but the exact value can only be determined by making another layout. Thus the ideal relationship is ordinarily secured by a lengthy cut and try method.

With the aid of the accompanying charts, the maximum value of the pressure angle can be determined much more readily within a wide range of possible conditions. The results are correct to approximately two degrees.

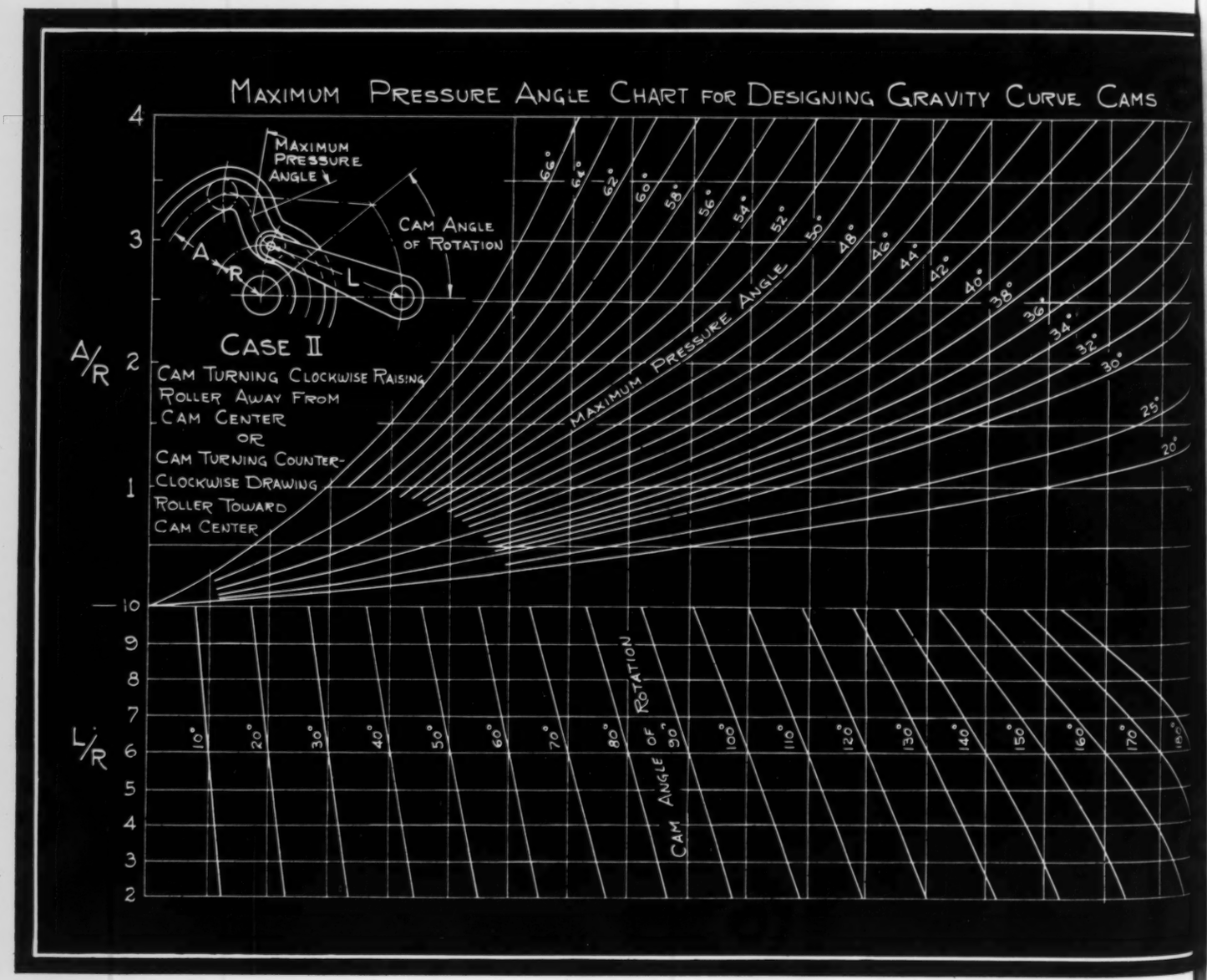
The charts are made for plate or internal track cams, the following being a pivoted lever carrying a roller running on the cam's surface, this form of construction being one of the most commonly used in all types of machines. Cam shape is based on the familiar "gravity curve", the acceleration and deceleration periods being divided equally and in the proportion of 1, 3, 5, 7, 9, etc.

As can be seen from the diagram accompanying each chart, the path of the cam roller, if extended, must pass through the center of the shaft carrying the cam. This is also a familiar basis of construction.

In comparing the charts a few points well worth remembering in designing cams are graphically illustrated.

Case II represents the preferred condition, the construction giving the lower pressure angle for the same angle of rotation and A/R and L/R ratios. This same case also shows that a short follower arm giving a small L/R ratio is advantageous. In case I, a long arm is more desirable as a short arm increases the pressure angle, particularly for the larger rotating angles.

For those not so experienced in the details of cam construction, it may be well to state that the angle on the face of the cam between the minimum and maximum pitch radii, at the extreme points of the rise or fall, is not the same as the cam angle of rotation, the former being used only in the actual machining of the cam track.


MAXIMUM PRESSURE ANGLE CHART FOR DESIGNING GRAVITY CURVE CAMS
MAXIMUM PRESSURE ANGLE
CAM ANGLE OF ROTATION
A
R
L
CASE II
CAM TURNING CLOCKWISE RAISING ROLLER AWAY FROM CAM CENTER
OR
CAM TURNING COUNTER-CLOCKWISE DRAWING ROLLER TOWARD CAM CENTER
A/R
L/R
MAXIMUM PRESSURE ANGLE
CAM ANGLE OF ROTATION
66° 64° 62° 60° 58° 56° 54° 52° 50° 48° 46° 44° 42° 40° 38° 36° 34° 32° 30° 25° 20°
10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110° 120° 130° 140° 150° 160° 170° 180°

New Machines Indicate Design Trends

IT HAS only been within the last few years that designers have really considered the pumps used in their machines in their true sense—as carefully designed engineering parts to be specified exactly as to type as well as by capacity. Each design of pump has a different field. Each should be carefully considered before the final choice is made in order to insure that the design will give exactly the characteristics wanted without wasted power, too great a supply of liquid or air, or at a cost which is too high for both machine user and machine builder.

Machines recently announced in addition to those on the next two pages include the following, arranged by fields of application:

Chemical

Rotary Steam Dryer, W. S. Tyler Co., Cleveland.

Construction

Scraper-Loader, Sauerman Bros. Inc., Chicago.

Internal Vibrator, Flexible Road Joint Machinery Co., Warren, O.

Concrete Vibrator, R. W. Baily, Philadelphia.

Dairy

Milk Clarifier, De Laval Separator Co., Poughkeepsie, N. Y.

Domestic

Washing Machine, Getz Power Washer Co., Morton, Ill.

Ironer, Nineteen Hundred Corp., Binghamton, N. Y.

Washing Machine, Blackstone Mfg. Co., Jamestown, N. Y.

Beverage-Food Cooler, Portable Elevator Mfg. Co., Bloomington, Ill.

Stoker, Holcomb & Hoke Mfg. Co., Indianapolis.

Stoker, Kelvinator Corp., Detroit.

Industrial

Electric Screw Driver, Chicago Pneumatic Tool Co., New York.

Spray Painting Equipment, Paasche Airbrush Co., Chicago.

Gear Speeder, Michigan Tool Co., Detroit.

Unit Heaters, Young Radiator Co., Racine, Wis.

Vapor Spray Cleaning Equipment, Homestead Valve Mfg. Co., Coraopolis, Pa.

Metalworking

Double-Acting Hydraulic Press, Baldwin-Southwark Corp., Philadelphia.

Two Column Press, Oilgear Co., Milwaukee.

Automatic Wire Straightening and Cutting Machine, Lewis Machine Co., Cleveland.

Pedestal Grinders for Cemented Carbide Tools, Carboloy Co., Detroit.

All-Welded Press Brake, Boom Boiler & Welding Co., Cleveland.

Tool Room Surface Grinding Machine, Diamond Machine Co., Providence, R. I.

Packaging

All-Purpose Labeling Machine, New Jersey Machine Corp., Hoboken, N. J.

Feeding and Packaging Machine, Bostitch Sales Co., East Greenwich, R. I.

Bag Filling Equipment, Julius Frank Machine Works, Chicago.

Machine for Nonflowing Products, J. L. Ferguson Co., Joliet, Ill.

Printing

Plate Finishing Machine, Ostrander-Seymour Co., Cicero, Ill.

Vertical Rotary Miterer, H. B. Rouse & Co., Chicago.

Rubber

Testing Machines, Henry L. Scott Co., Providence, R. I.

Textile

High Speed Silk Warping Equipment, Sipp-Eastwood Corp., Paterson, N. J.

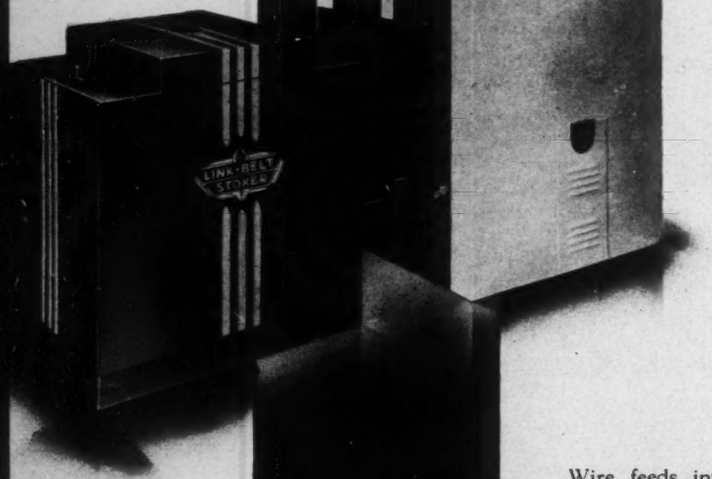
Forced feed lubrication is provided throughout on the Wickes automatic crankshaft lathe, left, which is driven by a variable speed direct current motor.

odernistic steel hous- encloses coal hopper, tor, fan and trans- ssion on new model k - Belt residence e automatic coal ner, below. Rubber untings on fan and tor absorb noise and ration.

Bearing brackets are integral with the molded Durez case for the new Packard electric shaver, above. The machine employs a high speed electrically-operated clipping mechanism. Plastic material is used for light weight and permanence of finish.

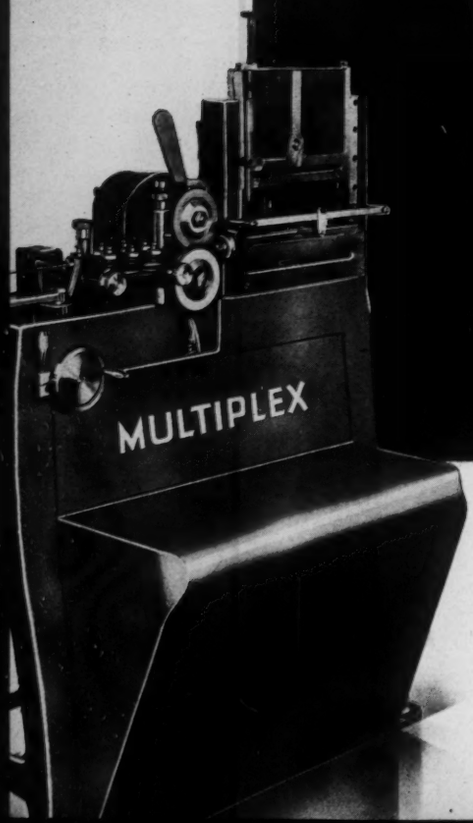
Design in New

A Pictorial Presentat from the Stan

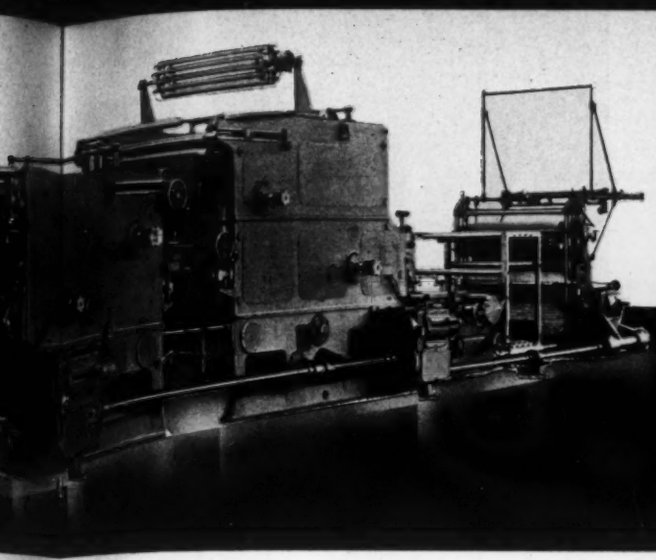


Wire feeds into new Multiplex wire forming machine, left, from a reel, is automatically straightened, cut to the desired length, and formed with dies to exact specifications. Length of wire being produced can be varied while machine is in motion.

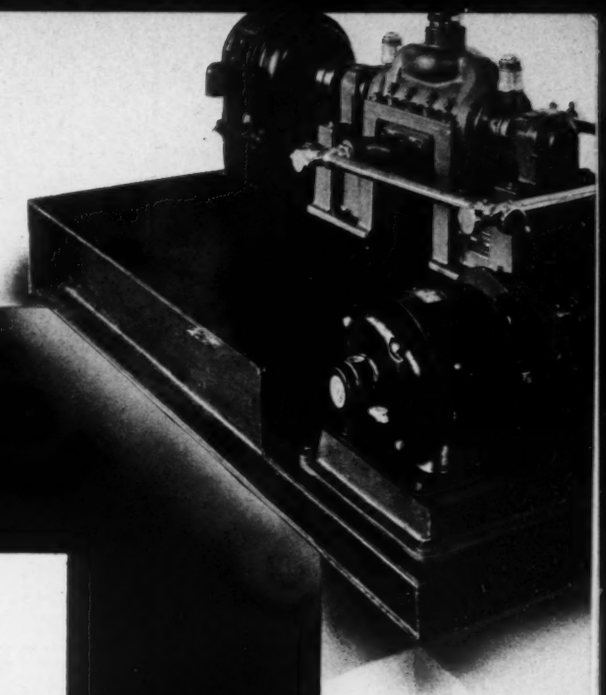
Adjustable drum design on Porter-Cable floor sander includes hardened spiral relieved-type cams. A valve on the machine permits attachment of an ordinary vacuum cleaner after sanding is completed. Bearings, of the Lubri-Seal type, are lubricated for the life of the machine.



Mechanical intake valve action on Schramm Diesel compressor, right, assures correct timing of air entering the pistons. Unloading is controlled by air pressure regulating the action of the unloading valves.



A single lever reverses the new Morrison Sanforizing range both mechanically and electrically. Definite relation of the various units is maintained by quick change gear boxes.

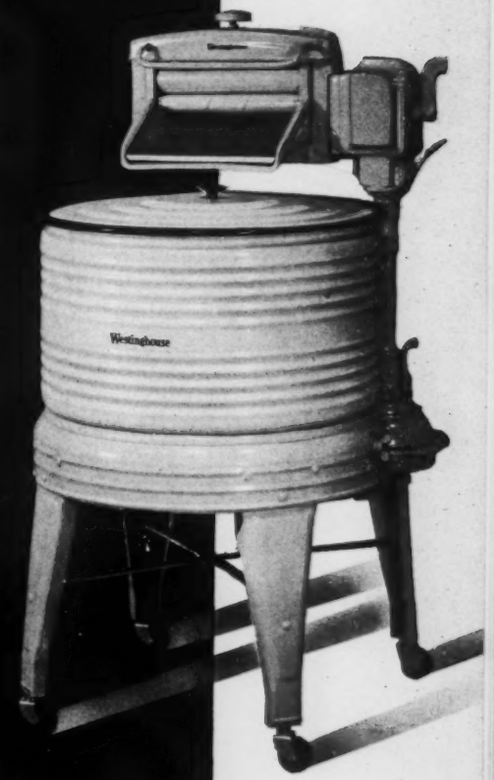


Air is definitely excluded and foam-free product assured with Lancaster disperser, right, by operation with internal pressure on stuffing boxes. Dispersion is not dependent on close clearances.

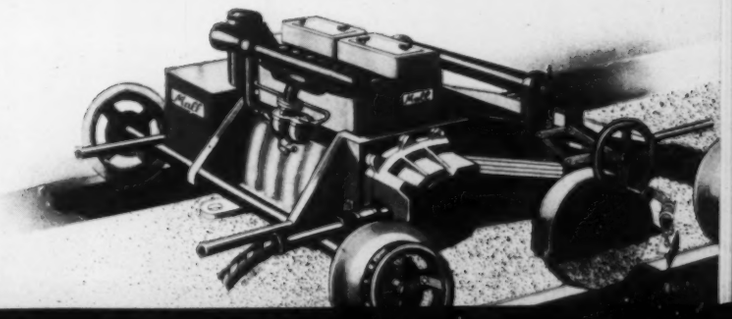
gn Features ew Machines

Presentation of Recent Machinery the Standpoint of Design.

Mechanism of new Westinghouse washer is fully enclosed with sealed-in lubrication. The lid is equipped with an interlocking device which prevents raising of the lid while the spinner is in operation. Perforated wings and small ribs give 720 separate water actions per minute



Wheels of Mall rail grinder, right, are of aluminum with cast steel rims for light weight. Curve grinding is facilitated by a spring counterbalance. An adjustable pivot turning device provides for a quick change of grinding work on either rail. Positive grinding feed is assured by a toggle motion.



MACHINE DESIGN

Design and Development Turning Losses into Profits

THE emphasis is on design! Signs abound. One has only to scrutinize domestic machinery, office equipment, automobiles or machine tools to reach the conclusion that the designer is on the spot—favorably. These varied classes of machinery exemplify modern trends. Their redesign reveals conclusively the "burning of the midnight oil," the intensive thought expended on development, the relentless attempt to recreate a buyers' market.

One class at least of these machines is scheduled for still further—and rapid—progress. Oldsmobile is erecting a building specifically to accommodate its engineering department. Facilities available, from the engineering standpoint, will be increased sixty per cent.

That such concentrated attention to engineering brings ample returns is borne out by the recent statement of Thomas J. Watson, president of International Business Machines. This company, through adopting an aggressive attitude in the design of new machinery, has increased its number of employes from 235 to over 9000 during the last twenty-two years, holds 874 patents and makes 95 per cent of its profit from things developed by its own engineers.

Sooner or later, design and development will be accorded their rightful place. It should be "sooner." The times ahead will provide fertile soil for the growth of adequate recognition of the design profession.

Reduce Noise!

NOISE is "in the eye," as well as in the ear, at this time! Though increasing prominence has been given to this subject during the past few years, nothing has focused attention upon it so vividly as the recent adoption by the American Standards association of standards for noise measurement and for sound level meters.

These standards have not been established any too soon. With the constant development of higher and higher speed machinery comes the need for investigating and locating objectionable noises. These may be caused indirectly by the movement of elements such as air or lubricant, or by actual motion of machine parts such as cams, gears, etc.

It is safe to predict that in common with the high speed camera for observing and recording action in machinery, the sound level meter will quickly be recognized as one of the most promising of the new tools of design.

Professional Viewpoints

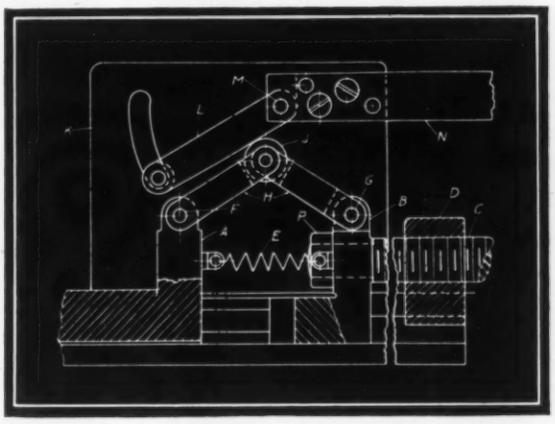
MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Slide Movement Is Variable

To the Editor:

QUITE often a mechanism is described which will give two different movements to two slides from one actuating source the difference in movement to vary from zero to maximum as required. Conditions of this type are met on diamond dressing devices for automatically dressing grinding wheels, or where, after a desired constant movement is given to both slides, a stripping action is desired.

This last condition was necessary in an automatic winding machine where, after a particular length of silk cording was wound upon a spool, the spool was stripped from the winding arbor on to another arbor in alignment with the first one.



Unique mechanism will give two different movements to two slides actuated from a single source

To obtain such a movement, slide *A* is placed within slide *B* which is then connected to a suitable screw *C* rotating in fixed bracket *D*. Normally, slides *A* and *B* are pulled toward each other by means of two springs *E*. To these slides at *F* and *G* are attached toggle links *H*. At the center of these links is a roller *J*. At *K* an upright piece is fastened to which is pivoted the adjustable cam *L*, at *M*. This cam plate is supported on the outboard side by riding arm *N*.

In operation the mechanism works as follows: As screw *C* is rotated at a uniform rate, slides *A* and *B* move forward simultaneously on parallel arm *N* until roller *J* comes into contact with adjustable cam slide *L*, after which slide *A* advances at a rate faster than slide *B* in an amount proportional to the steepness of the angle set by cam *L*. If the angle of cam *L* were small, the advance of slide *A* over slide *B* would be very little. As this angle increases, the rate of movement of the parts increases in direct proportion.

—JOHN A. HONEGGER,
New York.

Design Creates an Industry!

To the Editor:

LITTLE has been said or written about machine design as it affects the envelope industry, yet directly because of machine design development the envelope industry has risen in less than a hundred years from an obscure position to a size where today more than 8000 people find employment at an annual wage approximating from 8 to 10 millions of dollars, while the value of the finished product is estimated to be in excess of 40 million dollars yearly.

Thus in one industry engineers have created thousands of jobs that did not exist a hundred years ago. There can be no argument here about improved machinery swelling the ranks of the unemployed. Rather, it has produced an army of well compensated employes.

The envelope industry differs from the automobile and radio industries insofar as these two latter industries were created from new inventions whereas envelopes were used a hundred years before machines were introduced in their manufacture. For years and years stationers spent their spare time in the back of their shops folding and gumming envelopes. It was not until 1850 that engineers turned seriously to the task of designing an automatic folding apparatus. From that time on new machines for gumming

and folding envelopes have come and gone in rapid succession.

Today the modern envelope-making machine will produce more envelopes in a minute than the stationer's apprentice could produce in half a day. And in five minutes the modern machine will produce more envelopes than the old time stationer would sell in a week. The modern machine will fold and gum up to 450 blanks per minute over an indefinite period.

The machine designer has held a key position in the development of this industry. Because of his ability in developing such machinery we are able to purchase the finest envelopes at a fraction of the cost of those made by hand a century ago, and thus the market for envelopes is immeasurably increased.

—Roger C. Dickey,
International Paper
Box Machine Co.

Training a Design Department

To the Editor:

RIGHT in the middle of what proved to be one of the most prosperous years we have experienced in a long time, 1935, our design department ran afoul of a most distressing series of incidents that certainly taught us a lesson. We thought we knew all of the answers and all the ways out of difficulties, but we are still struggling in the mire of adversity. Our only solution seems to be hard work and good management, yet we would like to formulate a plan for the future. A discussion of similar plans encountered by your readers and a statement of the situation may serve to warn and advise others who are heading for the same abyss that has engulfed us.

Here is what happened to us, and may happen to a lot of others! For the past six years we have maintained a design department of ten men who were able to cope with all the problems of new and improved business and new models. Last June one of these obtained a place in the sales department, and was permanently lost to us. We didn't hurry to fill the place. Two weeks later one of our best men left for what he considers a better place, and in another week an old-timer was laid up with an illness that still holds him. All this created a need for manpower in a hurry.

Really good designers are harder to get than you can imagine. We found two experienced men, then hired two young fellows just out of school. Two of these four were wholly unsuited to our type of work and the other two quickly demonstrated how difficult it is to break in. Now we have six men with less than a year's experience and these six take the time of two others to advise, teach and act as reference for past work. Just five of our original ten can work on as usual. Our design costs have leaped, and all because we did not think it expedient to spend a comparatively few dollars to maintain a continuous flow of new talent into the department when we had the opportunity of training them carefully and well.

We are most certainly planning to bring in young men at regular intervals in the future. If there is not enough continuous design work, we plan to shunt them to other departments from which they can be recalled in emergency. But we would like to know how your other readers are tackling this problem. How they have cared for it in the past, and their future plans.

—Clyde Hearne,
New York.

Insuring Adequate Lubrication

To the Editor:

IN SOME types of mechanisms, where it is an involved problem to get oil to the bearings readily, lubricant is introduced through the shaft itself, the shaft being hollow-bored and provided with outlet holes into the bearings. This is a form of lubrication which may or may not be successful, especially in those cases where the attempt is made to force grease to two or more bearings from one grease cup at one end of the shaft. Where this attempt is made, the chances of failure are great.

Given a shaft turning in two bearings, and one grease channel leading to both of those bearings from the grease cup, an equal amount of lubricant will be fed into each of the bearings just as long as the amount of clearance in each one is equal. However, it is usually the case that more wear will develop in one bearing than in the other, and when that occurs, most of the grease will be forced into the looser bearing, following the path of least resistance. Where considerable difference in clearance exists between the two, the tighter bearing will receive hardly any lubricant at all, nearly all of it going through the one.

Under such a condition, failure of the tighter bearing is simply a question of time. It follows that it is better to have an individual channel and grease cup for each bearing served through the shaft. By introducing grease through both ends of a shaft two bearings can be served in this manner with safety, and it is seldom indeed that there are more than two otherwise inaccessible bearings on a given shaft.

—John E. Hyler,
Peoria, Ill.

MEN of MACHINES

AT THE age of fourteen Edward Bausch built his first microscope and now at eighty-two, with scores of patents to his credit, he still is actively designing optical instruments and machinery. At present a patent is pending on a new contour measuring projector of which he is the joint inventor.

Dr. Bausch, who is chairman of the board of Bausch & Lomb Optical Co., is largely responsible for the introduction of machine methods in the optical industry. An influx of European instruments in the Eighties prompted him to devise new processes and machinery.

He is a Cornell graduate and holds honorary degrees from the University of Rochester. Also, he is a fellow of the Royal Microscopical Society, a member of American Microscopical society and Optical Society of America.

EDWARD BAUSCH

• • •

THE new chairman of the Iron and Steel division of the American Institute of Mining and Metallurgical Engineers is Clyde E. Williams. Like other authorities in the field of metallurgy, he wields considerable influence, both directly and indirectly, on the design of machinery.

Since 1929 Mr. Williams has been affiliated with Battelle Memorial Institute, Columbus, O., of which he now is a director. Prior to that date he was chief metallurgist for Columbia Steel Corp., San Francisco.

University of Utah is his alma mater. After receiving his degree he was employed in the lead and copper smelting industry on the West coast for two years. His record since embodies a wide and varied experience in the field of metals.

CLYDE E. WILLIAMS

• • •

OUTSTANDING as an engineer and an authority on technical education, Prof. Robert E. Doherty now steps into the presidency of Carnegie Institute of Technology. He will not, however, come to Pittsburgh permanently until the close of the college year when he will have completed his duties at Yale as dean of the school of engineering.

A former assistant of Dr. C. P. Steinmetz, Prof. Doherty has been a member of the Yale faculty since 1931 when he was appointed professor of electrical engineering. Three years ago he was made dean of the engineering school.

Born at Clay City, Ill., he attended the University of Illinois from which he was graduated in 1909 with a B.S. degree. Subsequently he joined General Electric and after completing his

ROBERT E. DOHERTY

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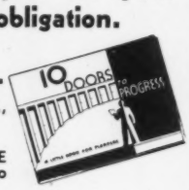

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student training, was appointed designing engineer for alternating-current machinery. In 1920 he received his master of science degree at Union college and three years later was appointed consulting engineer with General Electric. It was in 1925 that Prof. Doherty was selected to organize the advance course in engineering offered by that company. After a highly successful career in this work, Yale called him to its faculty in 1931, conferring upon him the same year the honorary degree of master of arts. Since his appointment at New Haven he has been active in educational programs of the professional technical societies.

♦ ♦ ♦

JEROME LEDERER has been appointed lecturer on air transportation at the Daniel Guggenheim School of Aeronautics at New York university. In 1927 he opened a practice as a consulting engineer in commercial aircraft design and in 1929 joined the engineering staff of Barber & Baldwin Inc. which was taken over in 1932 by Aero Insurance Underwriters of which he now is chief engineer.

♦ ♦ ♦

DR. FRANK B. JEWETT, president of Bell Telephone Laboratories Inc., has been awarded the Franklin gold medal by Franklin Institute in recognition of his many important contributions in the art of telephony. His picture and biographical sketch appeared in the June, 1932, issue of M. D.

♦ ♦ ♦

HARRY L. WILCOX has been made assistant chief engineer of Electric Controller & Mfg. Co., Cleveland. He is a graduate of the University of Michigan and from 1923 to 1925 was associated with Westinghouse Electric & Mfg. Co.

♦ ♦ ♦

JOSEPH S. DUNCAN, inventor of the addressograph machine, has resigned from the board of directors of the Addressograph-Multigraph Corp. because of ill health.

♦ ♦ ♦

G. P. HALLIWELL, formerly professor of metallurgy at Carnegie Institute of Technology, has been appointed director of research of H. Kramer & Co., Chicago.

♦ ♦ ♦

PAUL D. MERICA, formerly assistant to the president of International Nickel Co., has been made vice president.

♦ ♦ ♦

H. C. DICKINSON, head scientist, National Bureau of Standards, has been honored with a life membership in the Society of Automotive Engineers. He was president of the society in 1933.

♦ ♦ ♦

JOHN M. LESSELLS, prominent consulting mechanical engineer of Swarthmore, Pa., recently was appointed associate professor of mechanical engineering at Massachusetts Institute of Technology. He will be occupied with teaching and research in the field of engineering materials.

♦ ♦ ♦

J. D. WRIGHT and KARL H. RUNKLE have been appointed assistant managers of General Electric's industrial department. Mr. Wright formerly was assistant head of the industrial department's engineering staff and Mr. Runkle was manager of sales of the department's mining and steel

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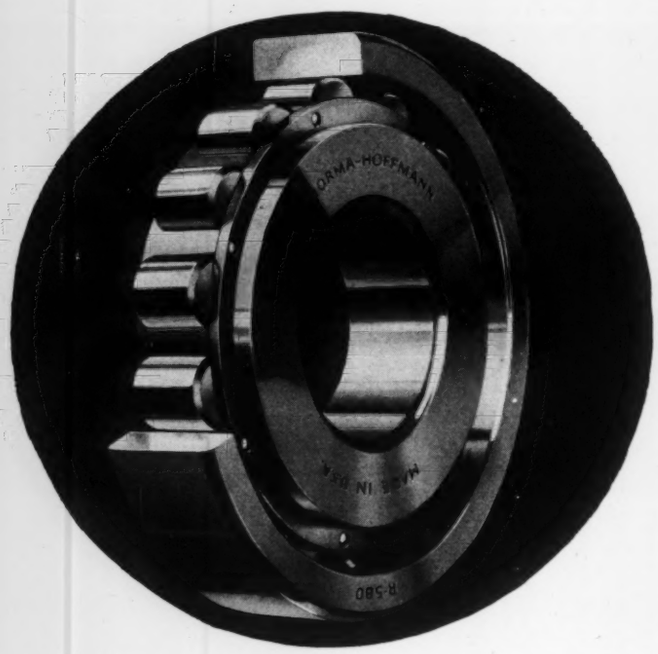

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mill section. Both entered G-E employ as student engineers after their graduation from college.

♦ ♦ ♦

A. J. Scaife has joined the Autocar Co. He will engage in engineering research. Until recently he has been affiliated with the White Motor Co. in various capacities in the engineering department.

♦ ♦ ♦

Mayo Dyer Hersey, Brown university, has been awarded the Louis Edward Levy medal by Franklin institute for his papers on the theory of lubrication.

* * *

William C. Reilly recently retired from a vice presidency of Youngstown Sheet & Tube Co. Since 1933 he has devoted his attention to development of new lines of products. Under his supervision the electric welded pipe department was perfected and the wide strip mill designed and constructed.

♦ ♦ ♦

Dr. Arthur L. Day, director, Geophysical Laboratory, Carnegie Institution of Washington, will deliver the Edgar Marburg lecture at the annual meeting of the American Society for Testing Materials at Atlantic City, June 29-July 3. He will discuss the subject of glass, in which field he is an outstanding authority.

♦ ♦ ♦

F. E. Ives who recently celebrated his eightieth birthday at Ithaca, N. Y., invented the half-tone process but never patented it. Later he developed the modern polychrome color-printing process and thus earned enough royalties to continue his research in color photography. He is still experimenting.

Obituaries

Samuel H. Lott, 54, associate professor, Stevens Institute of Technology, Hoboken, N. J., died recently. He was graduated from Stevens Institute in 1903. An authority on machine design, mechanical drawing and descriptive geometry, he rose to the rank of associate professor at Stevens, a position he held for the last 10 years. Professor Lott was well-known in technical engineering circles for his work in perfecting a mechanical engineer's scale. He was a member of the American Society of Mechanical Engineers.

♦ ♦ ♦

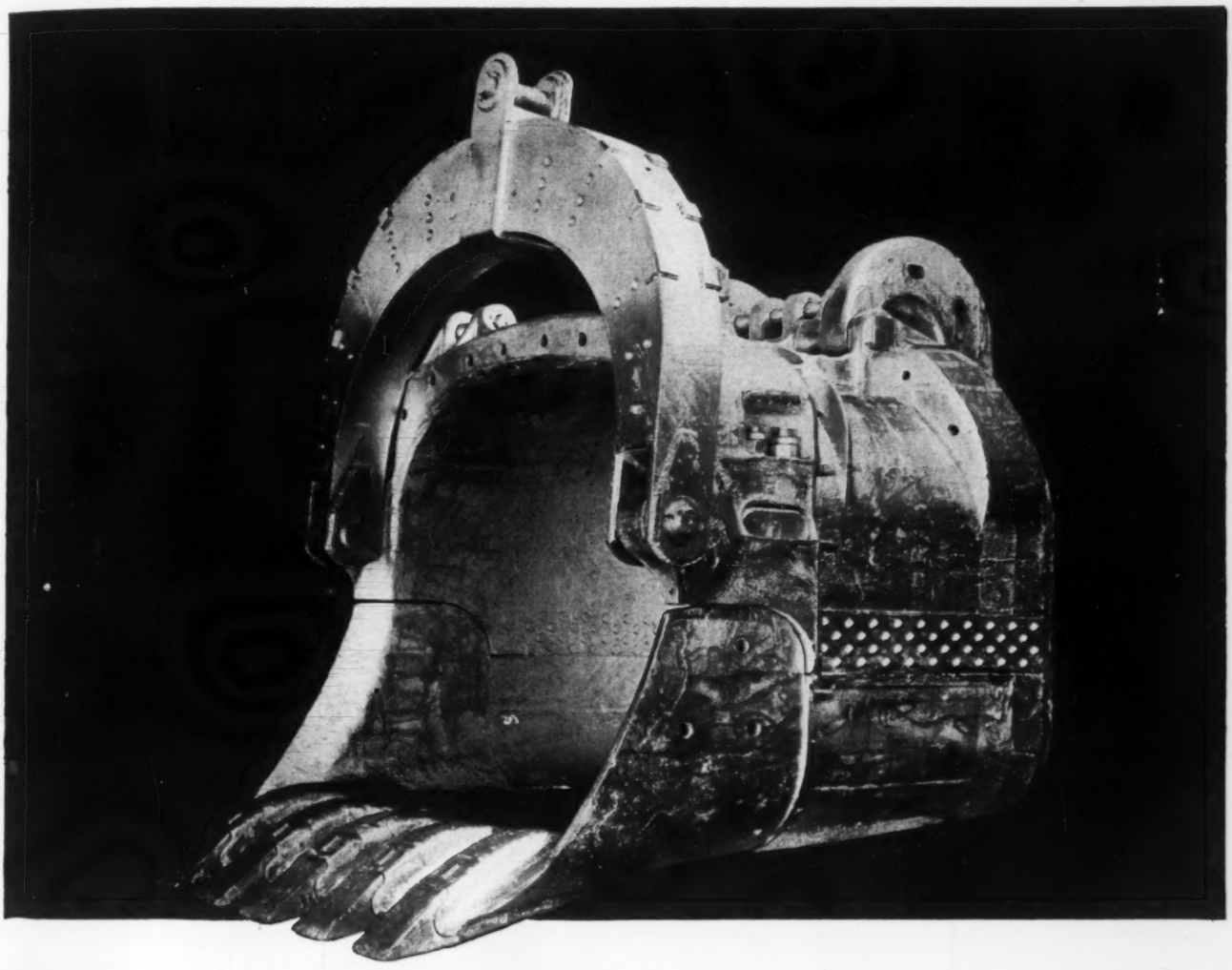
Alexander H. Boyd, 61, electrical engineer who perfected several devices used in the electroplating of metals died recently. He was at one time with General Electric and served as an executive in its Philadelphia branch for nearly 15 years.

♦ ♦ ♦

William H. Spire, an engineer and research worker for Thompson Products Inc. for 28 years, died recently in Cleveland. He was the first chief engineer for the late Charles E. Thompson, founder of the company.

♦ ♦ ♦

William C. Peyton, president of the Standard Stoker Co., New York, and the inventor of smokeless powder died recently at the age of 67.



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WRITE FOR BULLETIN DA2 which describes the STROBOTAC and other General Radio stroboscopic equipment.

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Assets to a Bookcase

Resistance of Materials

By Prof. Fred B. Seely; published by John Wiley & Sons Inc., New York; available through MACHINE DESIGN *for* $3.75 *plus* 15 *cents postage.*

Many changes have been made in the second edition of this book, including the addition of a number of new problems. It has been the author's aim in preparing the revision to give special emphasis to the engineering significance of the subject, and not merely emphasis to mathematical methods of analysis. Chapters cover such subjects as stress and strain, thin-walled cylinders and spheres, riveted and welded joints, stress and strain caused by torsional load, combined axial and bending loads, eccentric loads, repeated loads, fatigue of metals, etc. It belongs on the designer's bookshelf.

□ □ □

Graphical Solutions

By Charles O. Mackey; published by John Wiley & Sons Inc., New York; available through MACHINE DESIGN *for* $2.50 *plus* 15 *cents postage.*

This book on graphical solutions is the outgrowth of a course offered for many years in the school of mechanical engineering at Cornell university. While it is essentially a text book and the treatment is elementary, there are no doubt numerous practicing engineers who will wish to study this book. Chapters one to four cover stationary adjacent scales, sliding scales, network charts, alignment charts and combinations of these solutions. The fitting of equations to experimental data, another important task that frequently confronts the engineer, and methods of determining the values of the constants in nonperiodic equations are discussed in chapter five.

□ □ □

Elements of Diesel Engineering

By Orville Adams; published by Norman W. Henley Publishing Co., New York; available through MACHINE DESIGN *for* $4.00 *plus* 15 *cents postage.*

To the ever-increasing shelf of books on the subject of the diesel engines comes this volume. Its purpose is to assist the engineering student as well as the practical man in understanding the working principles and operation of the die-

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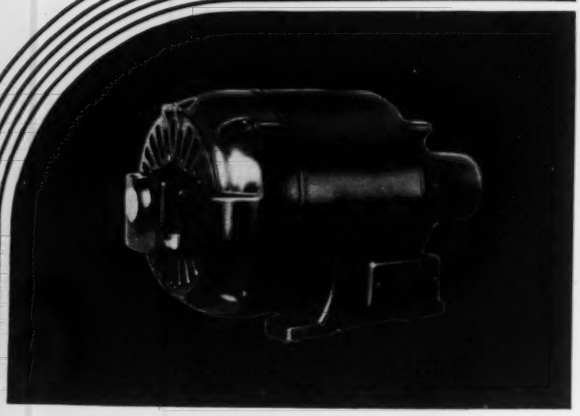

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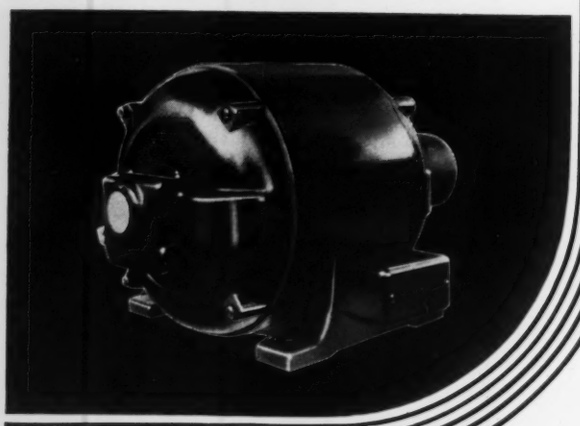


sel engine. The author in the compilation of data had the co-operation of leading designers and engineers in the industry, who furnished their experience and opinion. Phases covered present a comprehensive treatment of the subject. The book is worthy of a place in the library of every engineer interested in this timely subject.

□ □ □

Materials of Engineering

By Prof. H. F. Moore; published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for* $4.00 *plus* 15 *cents postage.*

In the fifth edition of this book, just off the press, a chapter has been added on the failure of materials by corrosion and by wear. Also much of the discussion on failure by creep has been rewritten to incorporate recent test results. Other revisions and additions include material on the properties of die casting metals, on the properties of synthetic resins and other plastics, etc. The author, Prof. Moore, is a well-known authority on the subject of engineering materials. His contributions are worthy of careful consideration by all designing engineers.

□ □ □

Diesel Engines

By L. H. Morrison; published by the American Technical Society; available through MACHINE DESIGN *for* $2.25 *plus* 15 *cents postage.*

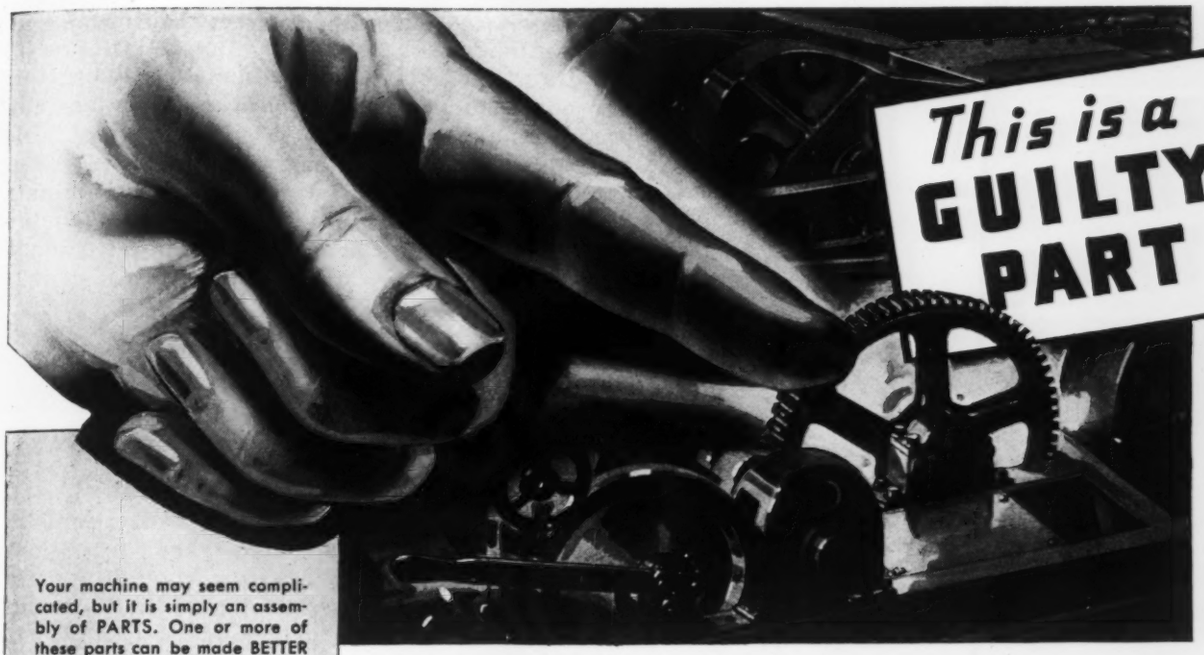
Another diesel engine book which offers a practical text on the operation and maintenance of heavy-duty engines. The author is the editor of *Diesel Power* and is an authority in this field. To present the information in a practical way he has chosen to divide the engine up, as it were, into unit parts, discussing each in respect to its construction, operation and maintenance. Design, of course, necessarily plays a prominent part in the explanation.

□ □ □

Metallurgical Dialogue

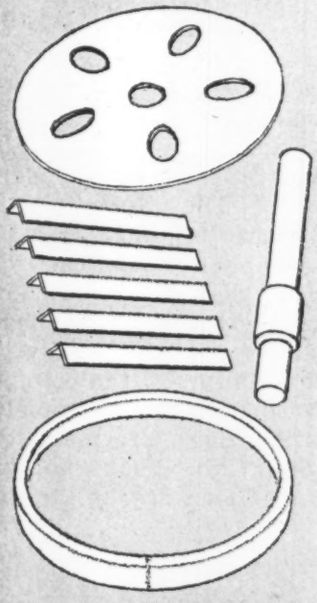
By Dr. Albert Sauveur; published by American Society for Metals, Cleveland; available through MACHINE DESIGN *for* $3.00 *plus* 15 *cents postage.*

Something unique in the presentation of scientific data has been attained by Dr. Albert Sauveur in his new book entitled, "Metallurgical Dialogue." His conversation with an imaginary student embodies questions simply put and clearly answered that will give the designer an evening of enlightening and profitable

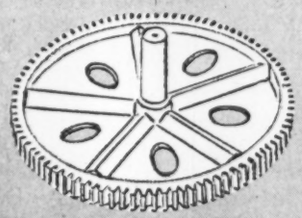


Your machine may seem complicated, but it is simply an assembly of PARTS. One or more of these parts can be made BETTER at LOWER COST by *"Shield-Arc"* Welding.

You can start now. Change one part at a time to *"Shield-Arc"* welded construction and thus reduce your costs and improve your product. Simply take standard mill shapes and cut them to proper size, like this—



Then assemble and fuse these shapes into a single unit by *"Shield-Arc"* welding, like this—



The Lincoln man nearby can show you how. He is at your service without obligation.

IT CAN'T "TAKE IT"

★ This cast iron gear could be changed to welded steel construction . . . made impervious to fatigue and impact fracture . . . made lighter . . . and *made for less money.* Until it *is* changed, it is a GUILTY PART in the manufacturer's product.

The odds are five to one that there is also a GUILTY PART of some kind in your product. Whether or not it is a gear is beside the point. Your machine is an assembly of *parts* and one or more of these parts can be made less susceptible to breakage . . . or lighter . . . or more rigid . . . or quicker . . . or at less cost . . . by *"Shield-Arc"* welding.

You can find out what this inefficient part is by calling in the Lincoln man nearby. And he will show you how to make it better at lower cost by using standard steel shapes and fusing them together by *"Shield-Arc"* welding. No obligation. THE LINCOLN ELECTRIC CO., Dept. C-249, Cleveland, Ohio. Largest Manufacturers of Arc Welding Equipment in the World.

P. S. The above gear has been changed to "Shield-Arc" welded construction. It is now unbreakable—weighs 20% less—costs 10% less.

LINCOLN

"SHIELD-ARC" WELDING

THE LINCOLN ELECTRIC CO.
Dept. C-249, Cleveland, Ohio

Show me some Guilty Parts in our product. Show me how to make them stronger, lighter, at less cost by *"Shield-Arc"* Welding.

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Name _____ Position _____

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LET THESE FELLOWS BRING *You* MORE *Power Hours*

"Power-Hours" are the dividends on your motor purchases. Here are the fellows that pull down *bigger* dividends for you when you use Dumore fractional horsepower motors:

1. Five-time inspection. (2) Dynamically balanced armature. (3) Commutator leads swagged by special Dumore process. (4) Commutator ground concentric with bearings. (5) Actually "run-in" to seat brushes. (6) Windings sealed against centrifugal "breathing." (7) Forced ventilation.

Dumore makes a complete line of series universal motors—1/600 to ¾ h.p.—D.C. or A.C., 0 to 60 cycles . . . the ideal drive for thousands of machines . . . husky shop grinders to fine jeweler's lathes . . . aircraft retractable landing gears to delicate telescope controls . . . all with smooth, dependable performance. You should have the handy Dumore catalog.

DUMORE MOTORS

MAIL THE COUPON FOR YOUR COPY

The Dumore Co.
Dept. 126-E, Racine, Wis.

Send your motor catalog and engineering service application blank.

Name.....

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City..... State.....

reading. Because Dr. Sauveur is Gorden McKay professor of metallurgy and metallography at Harvard he is well qualified to attempt this type of volume. Not only are the questions and answers pertinent to a majority of the basic problems in connection with metallurgy but they leave the information they disseminate more indelibly imprinted on the reader's mind than the perusal of the same data in a textbook.

□ □ □

Gates and Risers for Castings

By Pat Dwyer; published by Penton Publishing Co., Cleveland; available through MACHINE DESIGN *for $3.00 plus 15 cents postage.*

Because an understanding of foundry methods is essential to the designer such a book as this merits attention, even though written primarily for the foundryman. Its contents offer a complete encyclopedia, a ready reference and a practical guide. Five sections comprising twenty-seven chapters cover all varieties of gray iron, brass, bronze, aluminum, steel and malleable casting practice.

□ □ □

Practical Descriptive Geometry

By W. G. Smith; published by McGraw-Hill Book Co. Inc., New York; available through MACHINE DESIGN *for $2.50 plus 15 cents postage.*

This volume, the fourth edition, is divided into two parts namely "The Essentials of Descriptive Geometry," and "Applications." It presents both the Q plane and the analytical methods in greater detail than in any previous edition. Conceived as a textbook, assignments are more numerous, more varied and greater in engineering interest than in any of the volumes heretofore offered. Since descriptive geometry is the science of drafting there are many engineers who will find this book helpful, particularly those younger men new to the profession.

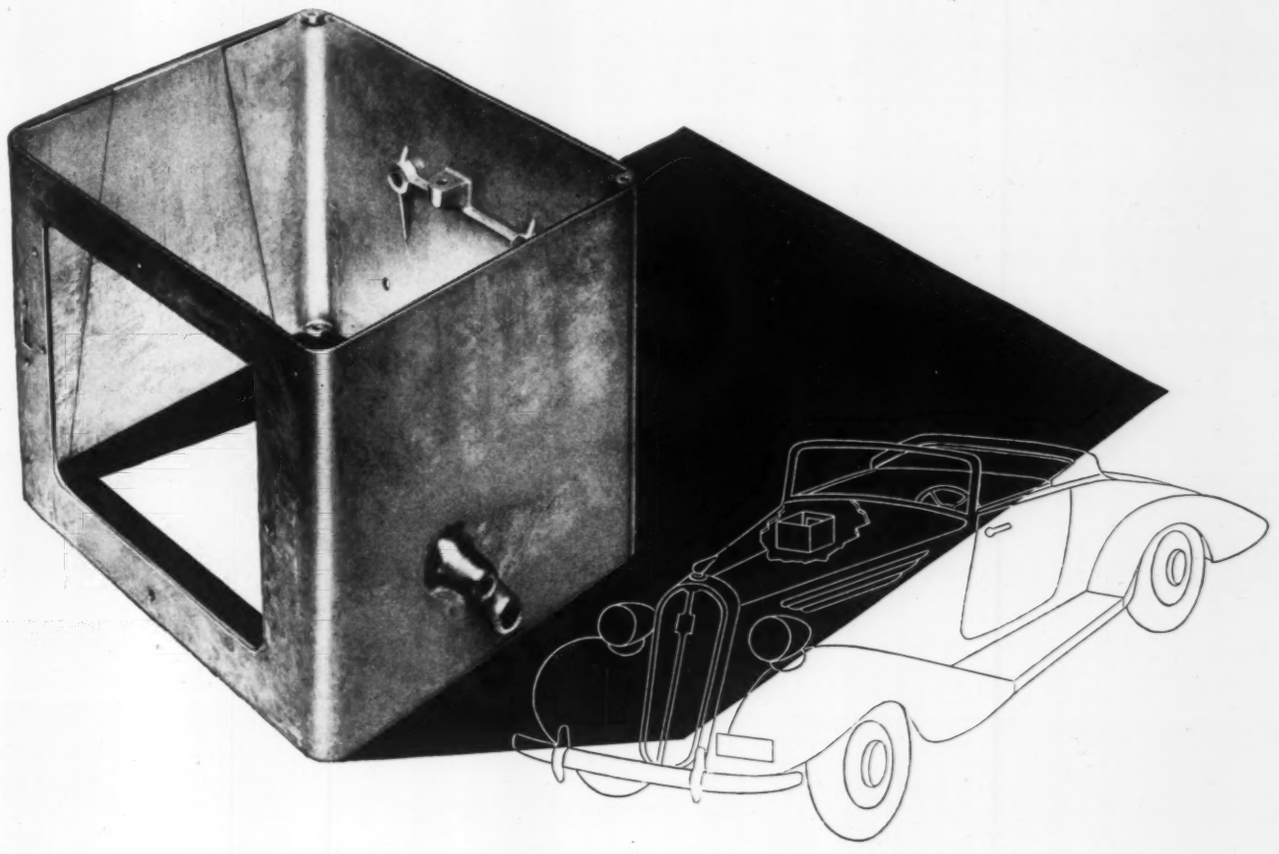
□ □ □

Elements of Motor Vehicle Design

By C. T. B. Donkin; published by Oxford University Press, New York; available through MACHINE DESIGN; *price $4.25 plus 15 cents postage.*

In the revision of this book, this being the second edition, the aim again has been to apply fundamental laws of mechanics to problems that arise in the designing of motor vehicles. Several sections of the volume have been rewritten and obsolete matter discarded. The chapter on gearing has been brought into line with recent advances in practice.

ZINC ALLOY DIE CASTINGS



THIS ONE TAKES THE BUMPS!

An automobile radio must hold its rigidity and the fewer the parts there are to loosen up, to rattle, the better. This ZINC Alloy Die Cast housing is rigid, provides strong bosses for connections and assembling elements . . . eliminates several joints, does much to eliminate rattles and microphonism.

The new ZINC Die Casting Alloys made with Horse Head Special ZINC furnish excellent die cast physical properties and can be counted on to maintain them over a long normal life. They have opened up so many possible applications for die castings that *many new products are now profiting from improved structural design, and production economies.*

It is worth every metal product designer's and manufacturer's time to investigate the possible advantages of redesigning for ZINC Alloy Die Castings. We will gladly furnish information on the possibilities and properties of these new alloys made with Horse Head Special ZINC.

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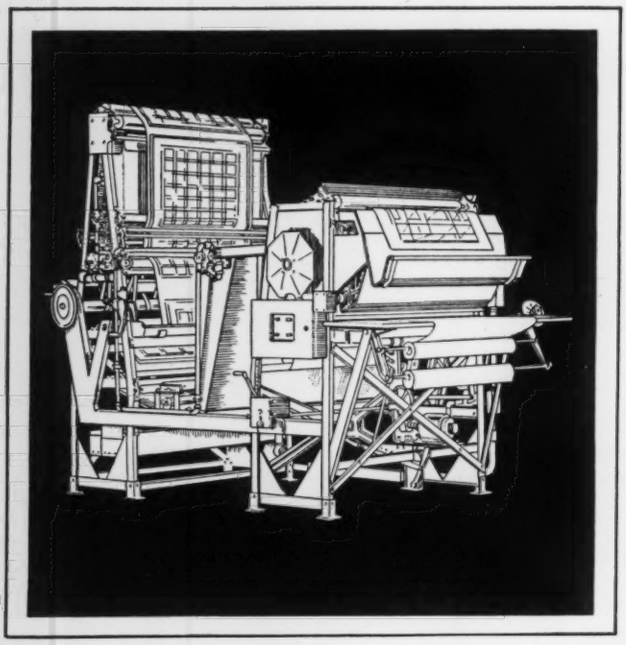
160 FRONT STREET (New Jersey Zinc) NEW YORK CITY



Cut Your Blue Printing Costs With This Amazing New Machine!

Model "11" was designed and built with just one thought in mind—to provide a high grade, continuous blue-printing, washing, potashing, and drying machine at an unusually low investment cost.

LOW PURCHASE PRICE

One of the most outstanding features of the Model "11" Equipment, of course, is its low price. Actually, it offers so much at such low initial cost and such low operating and maintenance expense that you cannot afford to make blue-prints on old or obsolete equipment any longer.

BETTER REPRODUCTIONS

Talk about high quality prints—more economical production—greater ease of operation—well, here it is combined in one machine as never before! Model "11" is easy to feed, easy to run, and even an inexperienced operator can readily learn, in a short time, to properly handle the equipment and turn out high-grade Blue-Prints, Negatives, Blue-Line and Brown-Line Prints with the utmost speed and high efficiency.

LOWEST OPERATING COST

Another outstanding advantage that recommends the Model "11" is its ability to help you keep reproduction expense at a minimum. See just what it can do for you in the way of providing better prints at lowest cost per square foot. You may have full information, engineering data, and prices on either the (42" or 54") Blue-Printing Machine only or the complete Blue-Printing, Washing, Potashing and Drying Equipment immediately upon request. Just ask for complete Model "11" facts and prices—now.

THE C. F. PEASE COMPANY
806 North Franklin Street, Chicago, Illinois.

PEASE MODEL "11"

strand of wire *C*, with the result that it is formed into helical convolutions *D*. These wires are laid on a core *E* led through the axial bore of a hollow shaft. Upon rotation of the lay shaft *F*, spindle *G* and its head *A* will be rotated by the gears shown in sketch *X*, together with cage *H* and its wire reels. The reels revolve around the spindle *G* and at the same time turn end over end and rotate, each on its own axis, to let off wires *C* under yielding tension of braking devices *K*.

When it is desired to compensate accurately for the elasticity of the wire, the head *A* and shaft *L* should be rotated in the same direction with each other but with the head rotating at a speed somewhat greater than that of the shaft, this difference serving to effect the relative speed of the carriers *M* to compensate for the elasticity of the wire, which would otherwise cause the production of a pitch of helix longer than that which the take-off demands, with resultant looseness in the lay.

Number of the patent is 2,036,393.

COMPENSATION for wear is provided in a feeding device patented recently by W. A. Smith Sr. In practice, rock drilling mechanism of this character is subjected to severe usage with the result that the parts such as the screw *A*, *Fig.* 2, and nuts *B* and *C* become worn to such a degree that vibratory movement between the parts soon reduces the threads to a state of uselessness. To overcome this condition Mr. Smith employs shims *D* interposed between the nuts. These shims assure body contact between the sides of the threads on the feed screw and nuts. More shims may be added as additional wear takes place. The patent is assigned to Ingersoll-Rand Co. and is designated No. 2,027,562.

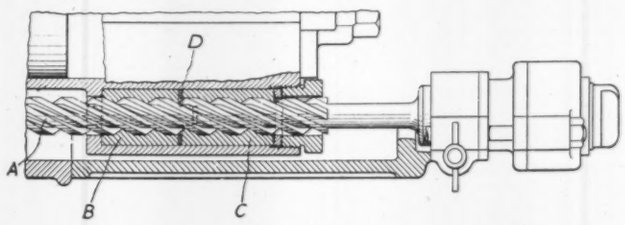
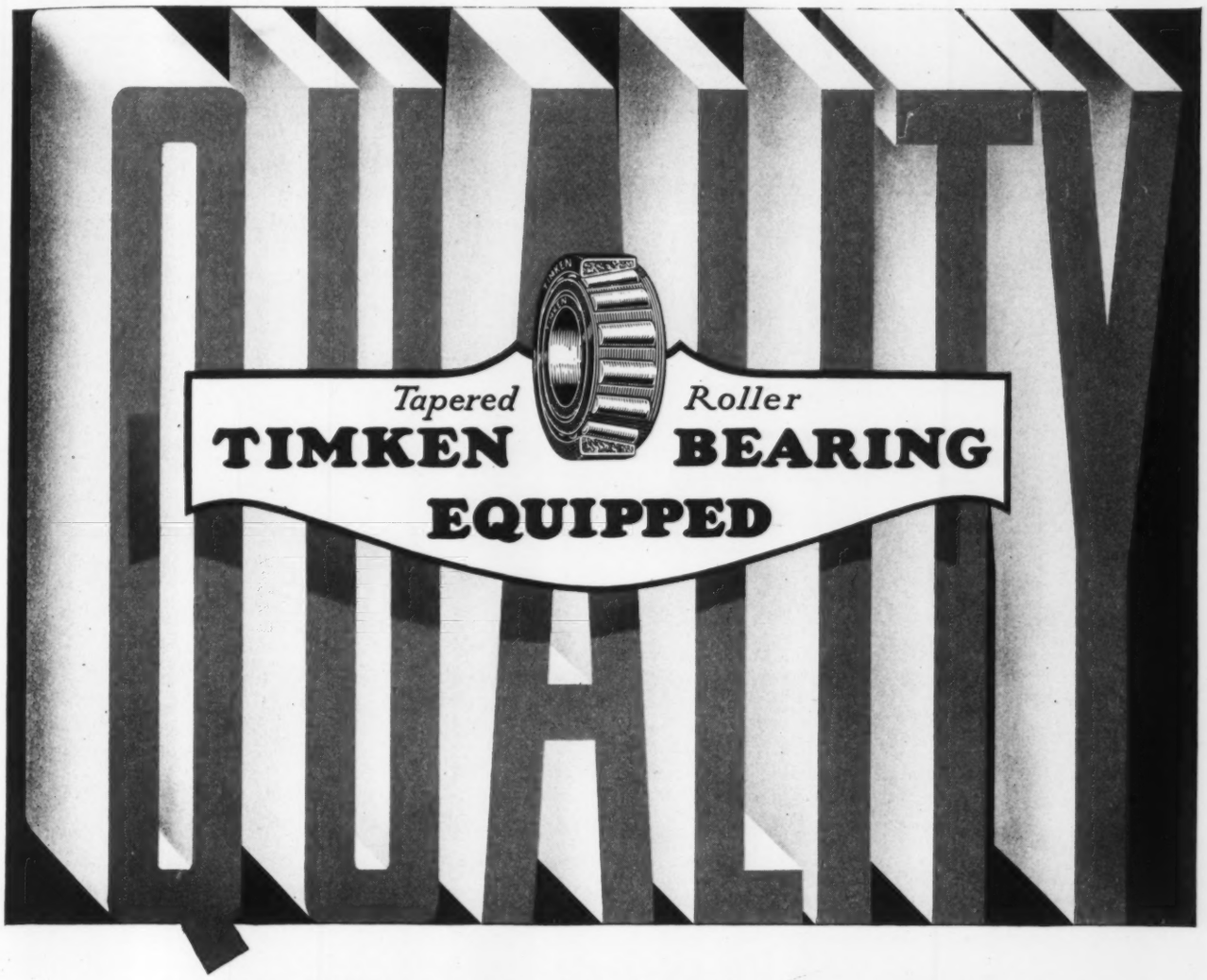


Fig. 2—Shims interposed between nuts compensate for wear in screw feeding device for rock drill

OVERHEATED condition of a roller or other type of antifriction bearing is indicated by a new telltale device patented by Henry H. Wood for Timken Roller Bearing Co. As shown in *Fig.* 3, it comprises a hollow cylindrical container or cartridge *A* mounted in a longitudinally split tubular lining member *B* that is secured



A SYMBOL OF QUALITY FOR EVERY MACHINE TOOL WITH WHICH IT IS ASSOCIATED

When a manufacturer thinks enough of his equipment to give it the advantages of Timken Bearings, it can be taken for granted that the product possesses outstanding merit. That is why it pays to look for Timken Bearings—and the Timken Bearing Equipped symbol — when buying any kind of industrial equipment.

Timken Bearings are used in leading makes of machine tools — on spindles, in gear boxes and feed mechanisms — to eliminate friction and wear; to carry radial, thrust and combined loads; and to hold moving parts in correct and constant alignment.

In doing so they assure higher speeds; greater precision; increased production; decreased operating and maintenance costs; and extended machine life.

The equipment buyer has a wider range of choice now than ever before — but he cannot go wrong with "Timken Bearing Equipped" as his guide.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *TAPERED ROLLER* **BEARINGS**

SHAKEPROOF LOCK WASHERS

Only ¼ Turn Locks Tight...

Speeds up production . . . cuts costs!

● Many manufacturers have been amazed at the saving made possible on the production line by the use of Shakeproof Lock Washers. Being made in a solid circle, they are easier to handle—resulting in faster assembly. When the nut or screw head touches the twisted teeth only one-quarter turn locks it tight and this means valuable seconds saved on numerous operations. And, besides these important production advantages, the powerful locking action of Shakeproof's exclusive tapered tooth design provides the utmost in vibration protection, assuring perfect performance and complete customer satisfaction. A test on your own production line will convince you—write for samples today!

SHAKEPROOF LOCK WASHER COMPANY

Distributors of Shakeproof Products Manufactured by Illinois Tool Works

2551 N. Keeler Avenue Chicago, Illinois

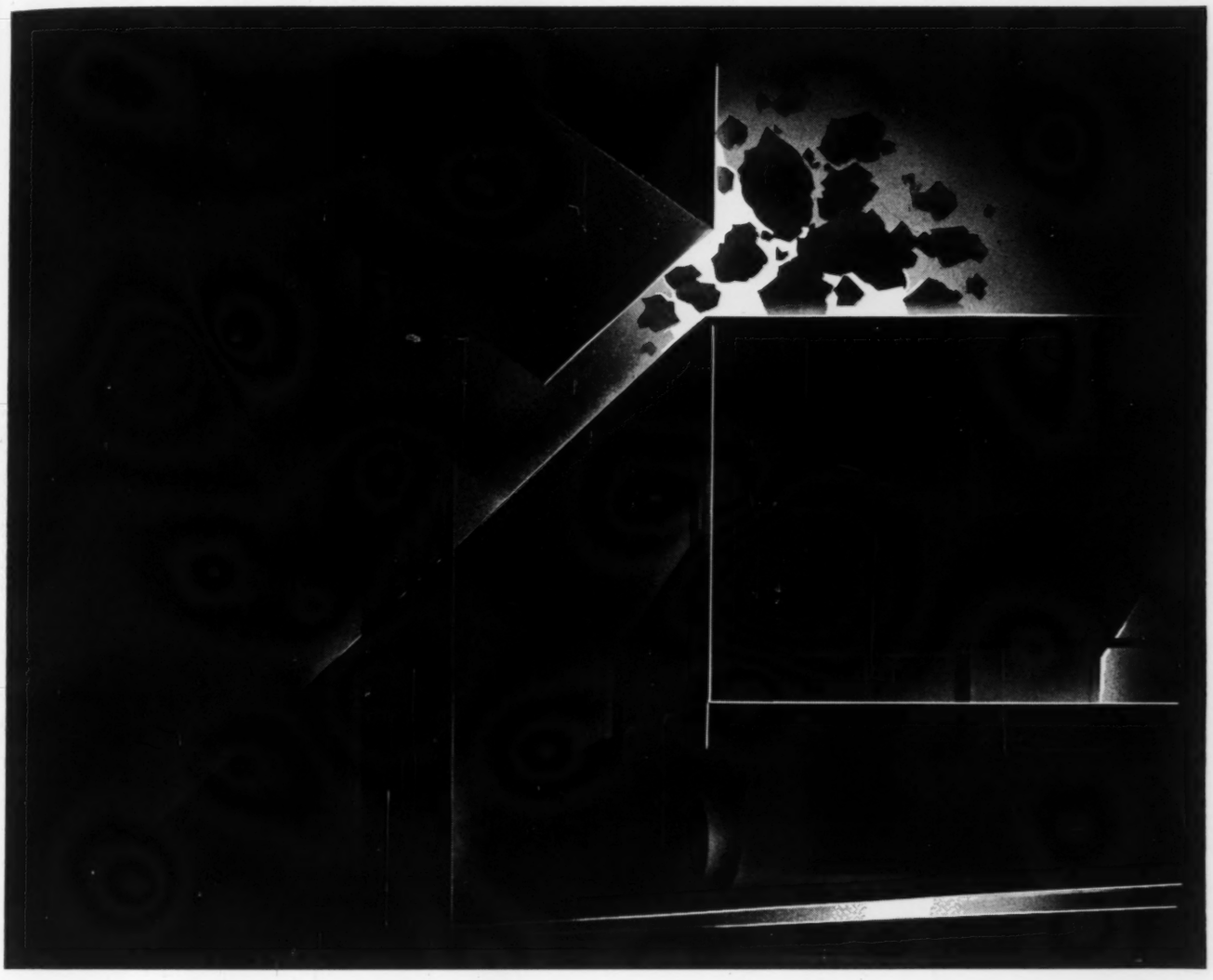
in the bore of the housing by a tack weld *C*. The cartridge is provided at its inner or bearing-opposing end with a mouth or opening through which the container is supplied with a suitable odoriferous and/or a smoke-producing compound. In event the bearing becomes heated to a critical temperature due to defects or unusual conditions, the heat is transmitted from the bearing cup *D* to a fusible plug *E* through the thin wall of metal separating the cartridge re-

Fig. 3—Telltale device embodied in roller bearings indicates any overheated condition that might arise

ceiving bore *F* from the cup. This heat is sufficient to melt stopper *E*, permitting the material in the cartridge to pass through the inclined passageway *G* to the atmosphere where the smoke and odor will act as a warning signal and thus indicate that the bearing requires attention.

CURRENT interest in cotton pickers brings to attention a newly patented doffing means claimed to be more effective in removing cotton from a rotating picking spindle than means heretofore employed. Edward A. Johnston is the inventor and International Harvester Co. the patentee. Rotating picking drum *A* carrying a plurality of rotatable conical picking spindles *B* is shown diagrammatically in *Fig.* 4. The doffer unit has a shaft *C* on which a number of doffing members *D* are mounted. Each doffing member embodies a series of blades *E* which project radially and are formed with horizontal edges aligned in a plane perpendicular to the axis of shaft C. The blades are set to operate as closely as possible to picking spindles *B* but without actual contact.

These positive doffing elements remove any cotton bolls or other foreign material which may be carried by the spindles, as well as the major portion of cotton fibers. However, it also is important to provide a resilient doffing element embodying two rows of spirally arranged bristles *F* in actual contact with the spindles to remove the remaining fibers and to maintain the spindles in a clean condition. If no actual con-



Where weight and expense are partners

It is estimated that reducing the empty weight of a railroad car one ton means an annual operating saving of $17.97 per car. The high weight-strength ratio of the "Moly" steels used in car construction permits an average reduction of 4.5 tons per car. Result: $89.85 annual savings per car.

That is vitally important itself. But — Moly steels are also exceptionally well fitted to withstand the terrific manhandling, abuse and corrosion that is the ordinary lot of rolling stock. Lower operating costs plus longer service permit greater profits.

Your steel problems may be—probably are—"different." They may involve creep strength or fatigue strength, or temper brittleness, or just plain fabricating economy. Whatever they are, it will pay you to investigate Molybdenum.

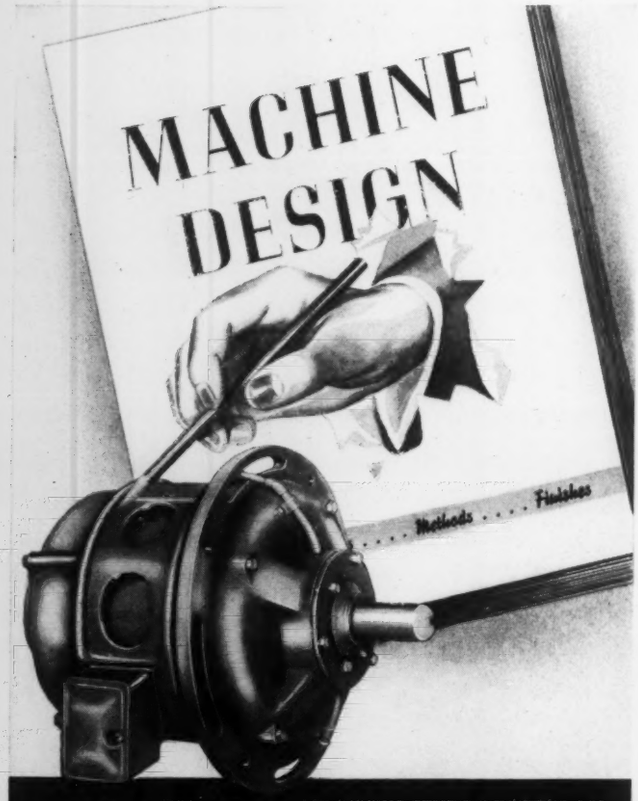
The wide experience of the engineers in our experimental laboratories is at your disposal. Our technical book, "Molybdenum," and our news-sheet, "The Moly Matrix," will gladly be sent you on request. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

Visit the Climax exhibit in booth 116 at the Foundry and Allied Industries Exposition in Detroit, May 4-9.

CUTS COSTS

MOLY

SALES



The Designer's
VIEWPOINT

The viewpoint of the machine designer has been very emphatically kept in mind in designing the broad line of Diehl motors. A check of any Diehl motor will quickly reveal this fact. Whether the motor is viewed with an eye to its operating characteristics, mechanical construction, appearance, or adaptability to special requirements, it will be found to conform to modern machine demands.

Diehl motors are standard equipment for machinery of almost every type. They have proved their efficiency and dependability in the air, on land and at sea. Diehl's design and production facilities are highly regarded by manufacturers of motor driven machines.

Utilize our fifty years of motor building experience in working out your problems of motor application.

DIEHL MANUFACTURING CO., Elizabethport, N. J.
Electrical Division of THE SINGER MANUFACTURING CO.
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DIEHL MOTORS

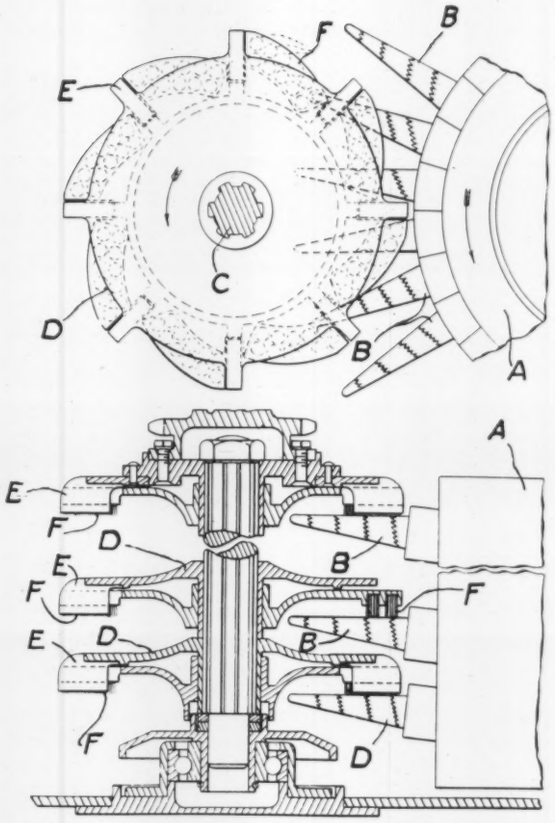

Fig. 4—Cotton picker doffing mechanism combines a rigid and a resilient element advantageously

tacting doffing means are employed a deposit of gum with which the cotton fibers will engage, is apt to collect on the spindles, forming a substance that cannot readily be removed by doffing means in any manner.

Number of the patent is 2,034,907.

AUTOMATIC SOLDERING MACHINE — 2,038,525—Seventeen claims. Paul E. Cate. Assigned to Fulton Sylphon Co., Knoxville, Tenn.

SPRAY COOLER—2,038,536—Eleven claims. Claude A. Bulkeley. Assigned to Niagara Blower Co., New York.

SPLINE COUPLING—2,038,544—Thirteen claims. John Edgar. Assigned to Barber-Colman Co., Rockford, Ill.

COATING MACHINE—2,038,561—Seventeen claims. John B. Hadaway. Assigned to United Shoe Machinery Corp., Paterson, N. J.

PAPER STRAIGHTENING DEVICE—2,038,568—Two claims. Hubert Jagger. Assigned to Ditto Inc., Chicago.

INDIVIDUAL WHEEL SUSPENSION—2,038,597—Ten claims. Ralph F. Peo. Assigned to Houde Engineering Corp., Buffalo.

SPROCKET WHEEL—2,038,695—Five claims. George W. Wilmot. Assigned to Wilmot Engineering Co.

CALCULATING MACHINE — 2,038,717 — Twenty-four claims. Raymond A. Christian. Assigned to National Cash Register Co., Dayton, O.

DRIVING MECHANISM—2,038,731—One claim. Gunner E. Gunderson. Assigned to Foote Gear Works Inc., Chicago.

DOUGH DIVIDER—2,038,733—Five claims. L. S. Harber and J. E. Pointon. Assigned to Baker-Perkins Co. Inc., Saginaw, Mich.

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You'll have your regrets if your product forgets—*for those that remember sell faster.*

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Bear in mind that many of the most profitable counter applications were obvious only after they were made. We work from ideas—and will be glad to give you suggestions that you may take advantage of or return to us, as you see fit. Write—in strictest confidence.

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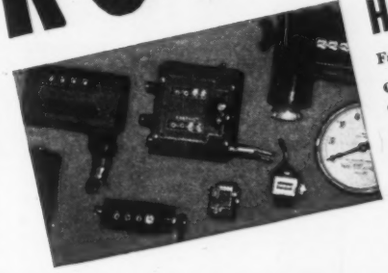

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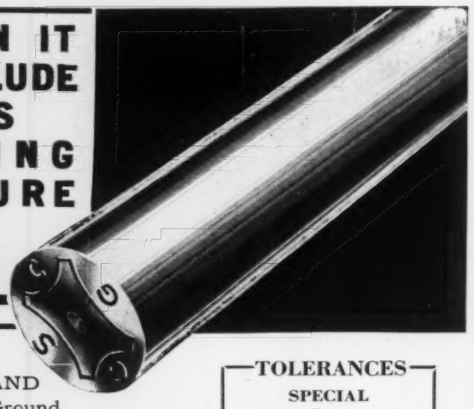

CUMBERLAND
Turned and Ground
STEEL SHAFTS
belong in your design . . . for their fine appearance and extra-quality are sales arguments convincing to machine buyers everywhere.

Turned, then ground to a super-smooth "mirror finish," Cumberland Shafts are accurate in diameter and straight . . . made for fast assembly. No need to ream, or file, or fit, even when gears, pulleys, sprockets, arms and bearings must slide on the shaft one after the other.

TOLERANCES

SPECIAL
(Any Diameter)
LIMITS ± 0.0005" or any other total tolerance of 0.001"

STANDARD

Small Dia. { +0.000" −0.002"

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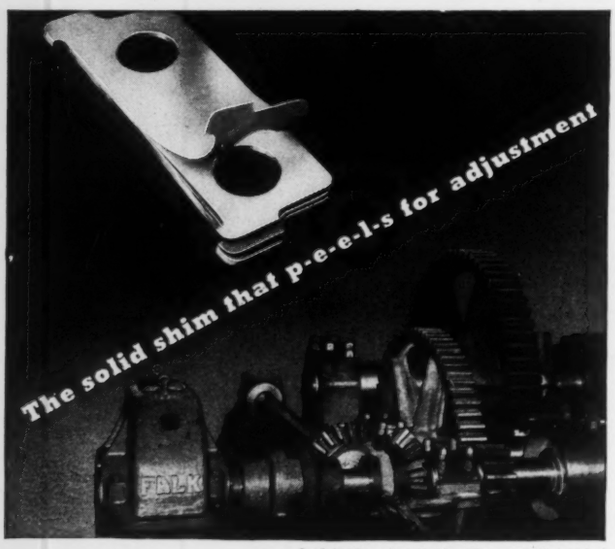
Investigate today. Write for your copy of our new folder. No obligation, of course.

Cumberland Steel Company
CUMBERLAND, MARYLAND
"86 Years in Business"



1 of 4 Milwaukee Bridge Co. operating units at Ruby Street bascule bridge, Joliet, Ill.

● precision bearing adjustments

By adopting Laminum shims Milwaukee Bridge Co. provides quick, accurate service adjustment for the life of the equipment.

You simply p-e-e-l one or more .003" laminations at a time from the shim. No filing . . . no miking! Write for sample shim.

THE SOLID SHIM THAT P-E-E-L-S FOR ADJUSTMENT
LAMINUM

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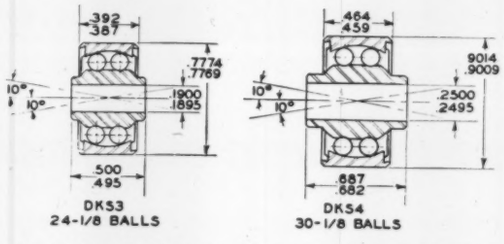
NEW *Materials and Parts*

Bearings Are Double Sealed

INTERNAL self-alignment is combined with double grease shield protection in the new group of ball bearings recently introduced by Fafnir Bearing Co., New Britain, Conn. These bearings, shown herewith, have been developed primarily to meet requirements of the aircraft industry, but have many industrial applications as well. They are of the double-row type, the two rows of balls operating on a spherical race surface on the outer ring to provide inherent self-alignment for shaft misalignment up to 10 degrees. The double metal shields are joined



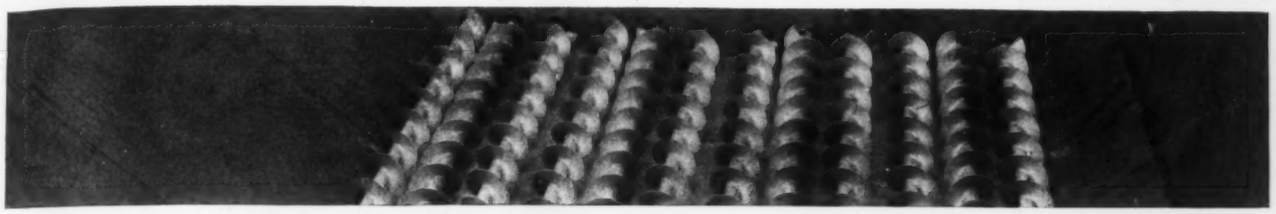
Shielded self-aligning bearings are supplied pre-packed with lubricant

to the outer ring, and maintain a minute but constant clearance from the inner ring at any position of self-alignment.

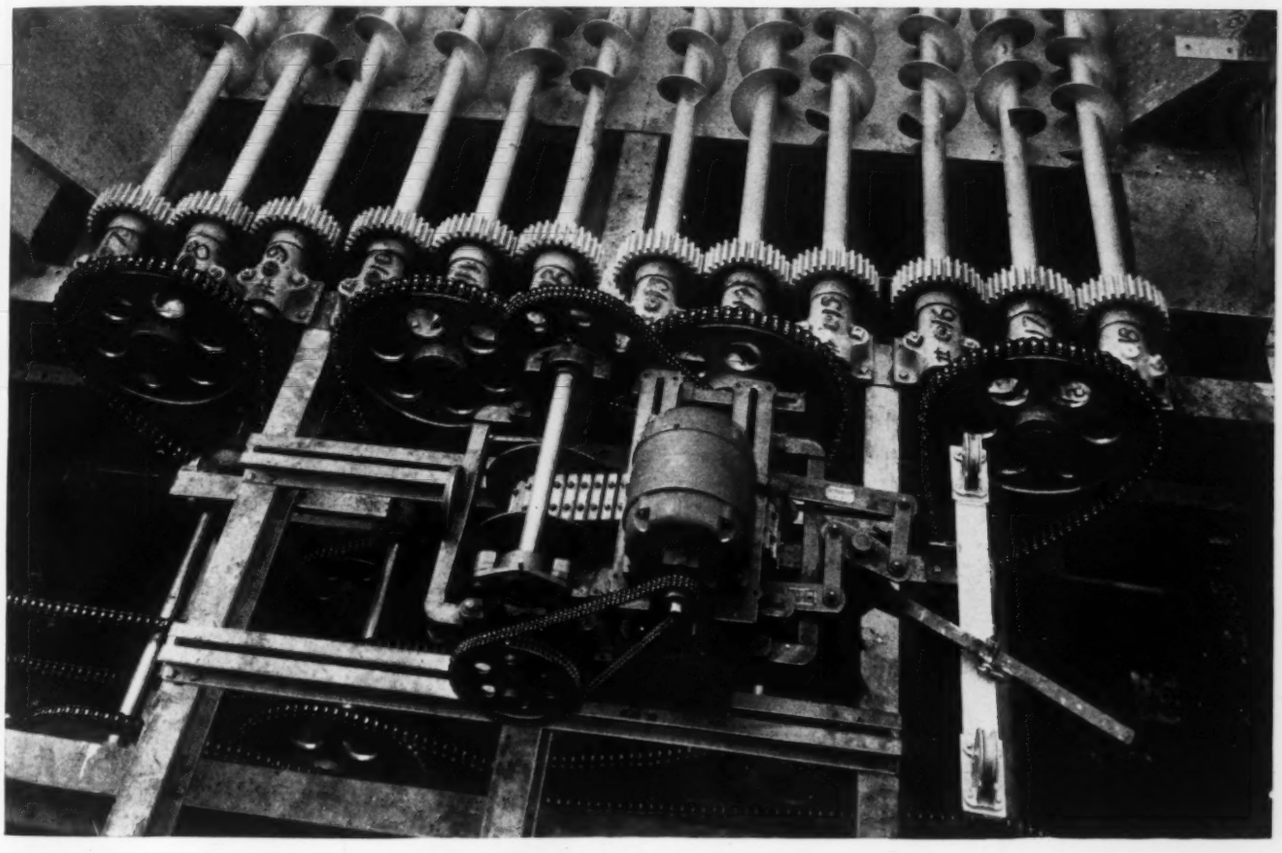
As in other bearings built by the company of the double-shield type, the new units are supplied prepacked with lubricant. Rings and balls are of SAE 52100 steel, and rings are cadmium plated on exposed surfaces for corrosion resistance. Dimensions for two bearings of this type are now available from stock as shown. The DKS-3 has a static radial nonbrinell capacity of 900 pounds and a static thrust nonbrinell capacity of 190 pounds. Capacities for the larger DKS-4 are 1100 and 240 pounds respectively.

Impact Strength Is Increased

MACHINING qualities are combined with higher impact strength in the new extra strength molding material, Durez 1544, developed by General Plastics Inc., North Tonawanda, N. Y., especially for molded parts such as machine parts requiring this higher than ordinary strength plus machinability. The material molds on regular cycles and performs automatically without difficulty. Impact strength has



21 DIAMOND CHAIN DRIVES
Subjected to Moisture, Heat, Dust—
Have You Some Unusual Application?



MANY separate drives—provision for variety of group motions—presence of moisture, heat, dust and dirt—were a few of the conditions the manufacturer of this stoker had to meet.

Diamond Roller Chain Drives—21 of them—met all of them—insured positive speed ratios, proper continuous operation at all times, exact timing of all functions, long life, and minimum of maintenance.

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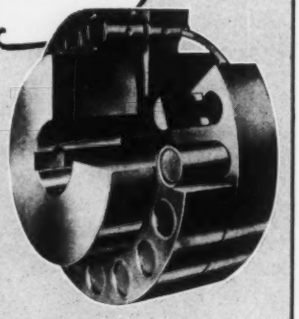
THE MOST VERSATILE POWER TRANSMISSION

FRANCKE
FLEXIBLE COUPLING

For Over 20 Years
the Best Known and
Most Widely Used



The FRANCKE design provides low initial cost and concentration of wear in a few component parts which can be quickly replaced without disturbing connected machine. Machine buyers know FRANCKE as an eminently satisfactory coupling on drives subject to shock load or vibration.

Kindly forward all inquiries direct to the main office or any of the branch offices of

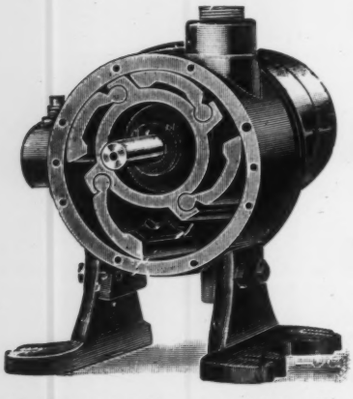
JOHN WALDRON CORP.
NEW BRUNSWICK · NEW JERSEY

Branch Offices

NEW YORK PITTSBURGH CHICAGO PORTLAND, ORE.

THE MACHINE DESIGNERS' FAVORITE AIR PUMP

Favorite because of its numerous sizes, its simple lines of construction, but above all because of its reliability —its positive performance which—just because it is so simple in design—can never fail to give its best.



LEIMAN BROS.
Patented Rotary Positive
AIR PUMPS
for pressure, vacuum and gas pumping

They Take Up Their Own Wear

Used on all worth-while automatic machines, paper feeders, bottle fillers, oil burners, and gas appliances.

Aerating — Agitating — Singeing — Branding — Preheating — Assaying — Brazing — Annealing — Soldering — Forging — Calliopes — Milking Machines — Steam Heating Systems — Paper Feeding Devices — Printing Presses — Oil Furnaces — Gas Furnaces — Coal Furnaces — Suction Chucks — Vacuum Cleaning — Solder Iron Heaters — Wrapping Machines — Mailing Machines — Testing Gas Fittings — Removing Foul Air — Supplying Fresh Air — Melting — Hardening — Massaging Machines — Laboratory Work — Blow Lamps — Blow Pipes — Glass Blowing — Gas Pumping — Testing Meters — Pressing Irons — Vacuum Frames

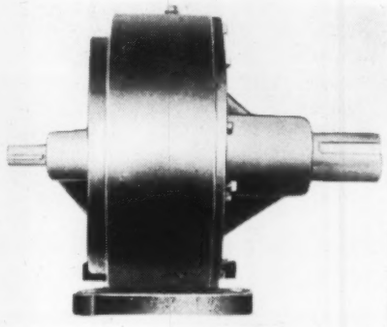
LEIMAN BROS., INC.

177 (5) Christie St., Newark, N. J.
LEIMAN BROS. N. Y. CORP. 23 (P5) Walker St., New York, N. Y.
Makers of Good Machinery for 45 Years

been increased to almost twice that of regular phenolic materials, and the finished moldings can be machined, sanded, buffed or wire-brushed without uncovering filler spots. Subsequent buffing of machined areas will bring up a rich black finish. The material weighs 22.4 grams per cubic inch.

Enlarges Speed Reducer Line

PLANETARY speed reducers in a new line have been added to the driving equipment, including worm gear units, being manufactured by Winfield H. Smith Inc., 107 Eaton street, Springville, Erie Co., N. Y. Compactness and high efficiency are said to be the outstanding features of the new unit, shown herewith. Antifriction bearings are used throughout and helical cut, heat-treated alloy steel gears insure quietness of operation. The new line has been especially developed for applications where large ratios of reduction are required. Ratios from 20 to 1 up to as high a ratio as desired are available. Efficiencies are reported as high as 94 per cent.



Quietness is secured in planetary speed reducers by use of helical cut alloy steel gears

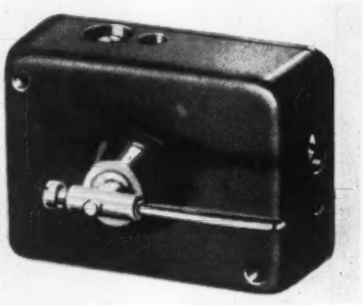
---

Provides Sensitive Control

SENSITIVE control of electrical circuits is provided by the new pilot switch introduced by Production Instrument Co., 1325 South Wabash avenue, Chicago. This extremely compact unit, Type ES-9, is housed in a molded Bakelite case which measures 1⅝ by 1⅛ by ⅝ inches and weighs one ounce. The operating arm is 1-inch long and the operating shaft projects ½ inch from the case. A pressure of ½ ounce on the operating arm is sufficient to operate the quick-acting switch.

There are but six parts in addition to the case in the unit, shown herewith. Phosphor bronze spring, coin silver contacts, and bronze shaft bearing are indicative of the type of construc-

tion. The switch can be furnished for a variety of uses, as it may be arranged to operate right or left hand, open or closed circuit, with reciprocal or rotary motion, and with any position of the lever arm. The make and break position may be accurately adjusted. It is rated ½ ampere alternating current and ¼ ampere



Control unit shown here at full size can be employed as a limit switch integral with the machine

direct current on inductive, resistance or lamp loads.

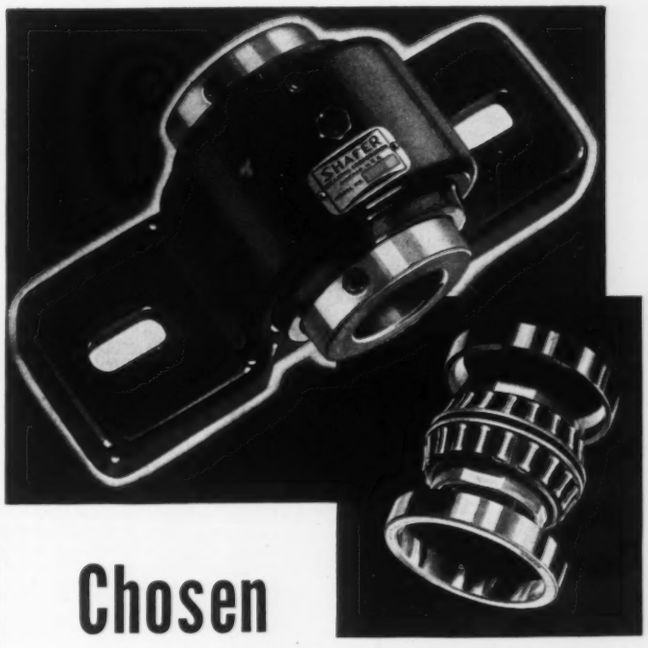
The switch is suited to the operation of electric counters and recorders, for signaling operations of many kinds, as a limit switch, for controlling motor operation, for alarm systems, in a wide variety of automatic controls, synchronizing operations, and other similar purposes.

Hose Provides Two Lines

RUBBER tubing, or hose, of radically new construction has just been placed on the market by Electric Hose & Rubber Co., Wilmington, Del. The tubing is especially designed for welding equipment and similar services. Twin hose are simultaneously molded with a connecting web between them, so that a cross section resembles a figure eight. A single length of this nonkinking hose is all that is necessary for equipment which heretofore has required two separate lengths. An additional advantage is that the hose has a special cord-wound reinforcement between the first and second braid. The hose is made with individual lines red and black or red and green, or other color combinations, or with both hose lines of the same color

Brake Is Actuated Mechanically

THE brake of the new style "E" combination magnetic clutch-brake being manufactured by Magnetic Mfg. Co., Milwaukee, is mechanically actuated through springs, and thus will stop the drive whenever the electric circuit is closed. The unit, shown herewith, is designed



Chosen

BY THE LEADING USERS . . . .

SHAFER

ROLLER BEARINGS

★ More and more leading manufacturers are turning to Shafer Pillow Blocks as standard equipment, because only Shafer combines the following advantages:

1. Full roller bearing capacity for radial, or thrust, or any combination of radial-thrust loads.
2. Integral self-alignment — within the bearing itself—without added bulk or extra weight.
3. Simple adjustability.
4. Compact, sturdy, one-piece housings — no need for ball and socket mounting.

Only Shafer Bearings are so readily adaptable to the widest range of uses, with simple installation and assured super-bearing performance. Investigate their value to you.

Available in a full range of sizes: Pillow Blocks • Flange Units • Take-up Units • Hanger Boxes • Cartridge Units • Duplex Units • Conveyor Rolls • Radial-thrust Roller Bearings.

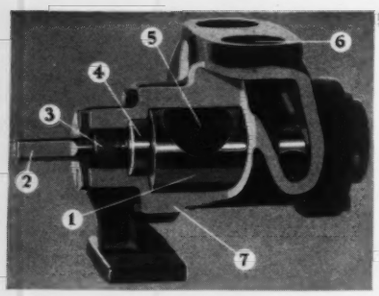
Write for Catalog 12-A.

SHAFER BEARING CORPORATION

6513 West Grand Avenue Chicago, Illinois

SHAFER

SELF-ALIGNING ROLLER BEARINGS



Benefit from ROTA-PISTON'S

7 Points of Superiority

ROTAPISTON Pumps are especially adapted to direct motor drive. Their 2-to-1 gearless reduction permits high speed, and therefore a less expensive motor.

Three standard sizes are built to interchange with other makes of pumps. Four other models are available with special mountings. Capacities range from 1/8 to 324 gallons per minute. Larger capacities on special order . . . Write for helpful folder.

1. Electric Iron Rotating Rotor. Rotates ½ speed at cam shaft.
2. Drop forged, hardened and ground Cam Shaft.
3. Packless Seal.
4. Ball Bearing, both ends.
5. Reciprocating Piston.
6. Pipe sizes large to handle volume at motor speeds.
7. Semi-steel Body.

THE GLOBE PRODUCTS CO.
4008 E. 89th St. Cleveland, Ohio

UNBRAKO

UNBRAKO HOLLOW SET

AFTER a great many years on the market the "UNBRAKO" is still among the top-notchers or in other words: None is better.

FREE SAMPLES OF BOTH SET & CAP

KNURLED UNBRAKO

All mechanics use their fingers driving Screws. Knurls gear fingers to head; fingers, therefore, have better purchase, drive faster and further.

Pliers bite the Knurled "Unbrako," but slip on Smooth-Heads.

Ask how we lock the Knurled "Unbrako" when countersunk—it's unique.

The Knurled "Unbrako" looks trim and attractive and dolls up any piece of machinery.

U. S. & Foreign Pats. Pending

ORDER BY NAME—SPECIFY THE KNURLED "UNBRAKO"

STANDARD PRESSED STEEL CO.

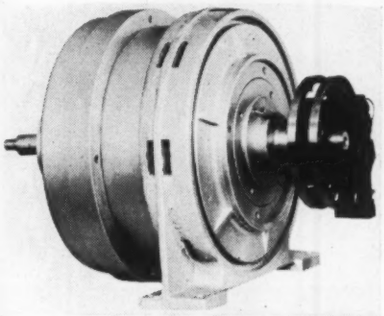
BRANCHES BOSTON CHICAGO DETROIT

JENKINTOWN, PENNA.
BOX 102

BRANCHES NEW YORK SAN FRANCISCO ST. LOUIS

to give quick, automatic stopping with positive safety at all times even in the event of interruption in the electric circuit. It is said to have smooth acceleration and lower power factor losses.

The unit combines a substantial friction area to provide maximum torque with greatest heat dissipation. There are virtually no moving or wearing parts with the exception of the friction linings. This type of clutch-brake has particular application on large machine tools, such as power presses, bulldozers, rubber and paper making machinery, brick and clay working machinery, and such similar apparatus where starting and stopping automatically through electrical control is of advantage. The part shown is 24 inches in diameter and develops a clutch torque of 4500 pounds feet and a brake torque of 1500 pounds feet.



Quick, automatic stopping with positive safety is possible with recently introduced magnetic clutch-brake

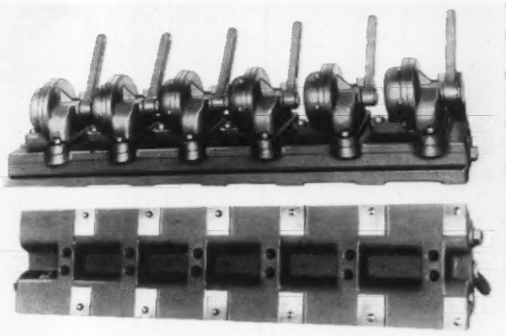
Improves Line of Air Valves

MANIFOLD-TYPE air control valves in a new and improved "Packless" type of compact construction and arranged for simple piping installation, have been brought out by Hannifin Mfg. Co., 629 South Kolmar avenue, Chicago. The valve shown in the accompanying illustration is for control of six double-acting air cylinders from a single point. Other types are available for control of any number of air cylinders, or air or hydraulic equipment of any other type.

The base of the valve is one piece, with inlet and exhaust ports at the ends, and cylinder ports in the bottom. Piping can be arranged in the simplest manner with a minimum number of connections. Inlet and exhaust connections can be made at either end of the base. Manifolds can be furnished with any number of valves required.

In the design, which has a minimum number of parts, a bronze disk, ground and lapped to seal with the seat which is similarly finished, controls the air flow. The valves are available

in 2 and 4-way types. Type MK has 45-degree movement, no shut-off position, air being admitted at all times to one side or the other of the air cylinder. Type MV has 90-degree move-

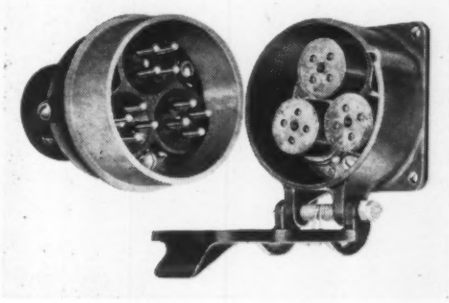


Controlling six double-acting air cylinders from a single point, valves are especially compact

ment with outlets open to exhaust when the lever is in shut-off position. Type MP has 90-degree movement with outlet and exhaust ports closed when lever is in shut-off position.

Multiple Outlets Are Introduced

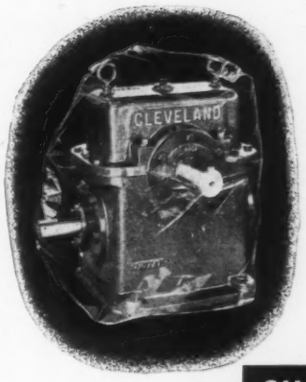
A NEW series of 20-ampere plugs and receptacles designed for multiple circuits of from 4 to 16 poles has been announced by Pyle-National Co., 1334 North Kostner avenue, Chicago. These parts are especially adapted to remote control circuits, thermo-couple connections, sound equipment, and similar applications



Multiple circuit receptacles have cast metal bodies with spring covers

in connection with the operation of portable equipment. The new line comprises two styles covering ranges from 4 to 8 poles, 6 to 12 poles, and 8 to 16 poles.

Receptacles have cast metal bodies with spring covers, providing protection against the weather, dirt or moisture. Female contacts are completely enclosed in high molded phenolic



The Ultimate Drive

SUPPOSE YOU COULD *look* RIGHT ON THROUGH

★ Imagine yourself looking clear through a Cleveland Worm Gear Speed Reducer, just as you are looking now at the housing through a transparent covering.

Here inside you would find ample evidence of sound engineering, based upon continuous research; of painstaking selection of metals; of precise machining practice; of newest methods of heat treating; of accurate testing.

To make these important elements *effective,* "Cleveland" continues its 24-year policy of building worm gearing and nothing else. It aims to disregard fads while recognizing merit and adopting sound improvement.

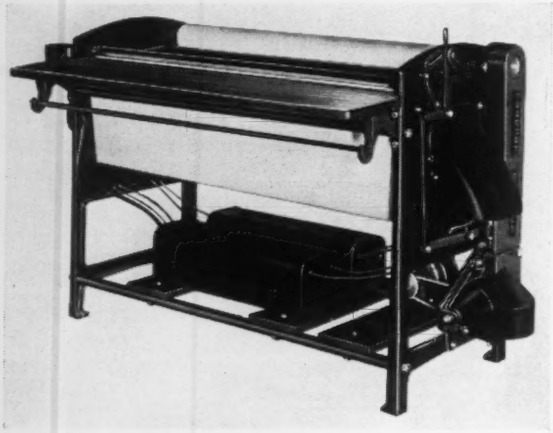
Operating records will show that the longer "Clevelands" run, the less their cost *per year*—because they require little or no maintenance.

May we send a District Representative to confer with you on any of your own design problems calling for efficient power transmission? The Cleveland Worm & Gear Co., 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

CLEVELAND WORM GEAR *Speed Reducers*

BLUE PRINTING EQUIPMENT



This Paragon SC Blue Printing Machine is a very useful general purpose machine for moderate requirements.

Write for detailed information and prices on this and on other types and sizes of Paragon-Revolute Machines. Literature gladly mailed without obligation to you.

PARAGON-REVOLUTE CORPORATION

77 South Ave. Rochester, N. Y.

Waukesha

METAL

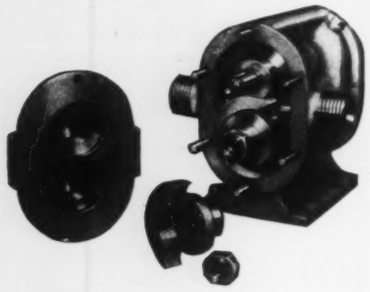
"A Nickel Alloy"

WAUKESHA

Metal is a corrosion-resisting, high nickel content, casting alloy especially adapted to use in fabrication of food handling equipment such as canning, baking, dairy, ice cream, beverage, distillery and brewery machinery.

Castings are nonporous, can be machined readily, will polish to a high permanent luster and can be cast from same patterns used for bronze or iron.

Made in various hardnesses and strengths for special applications.



WAUKESHA FOUNDRY CO.

Foot of Lincoln Avenue

WAUKESHA, WISC.

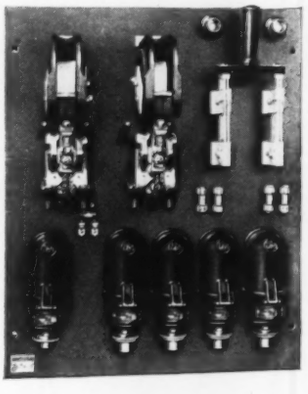
plastic insulation, giving protection against accidental grounding or short circuits. A key on the plug insures correct engagement in the receptacle contacts.

Plugs are heavy duty type with cast bodies designed to give full protection to the contacts, and can be furnished with strain relief bushings for portable cable. Insulation throughout is molded phenolic composition. Both male and female contacts are self-aligning to insure positive contact. Rated 20 amperes, 250 volts direct current, 460 volts alternating current, these multiple circuit plugs and receptacles are available in a full range of types to suit specific requirements.

Panels Protect Electrical Equipment

FOR use in protecting the electrical equipment used on electrically-operated cranes of the overhead traveling, locomotive and similar types, Electric Controller & Mfg. Co., 2721 East Seventy-ninth street, Cleveland, has brought out a complete line of new crane protective panels. These panels, shown herewith, are used in place of circuit breakers, knife switches, fuses, etc., which are otherwise necessary in the crane cab, and incorporate all of the necessary protective devices into a single compact unit requiring a minimum amount of space.

The units are complete with main line con-



Crane panels incorporate all necessary protective devices into a single unit

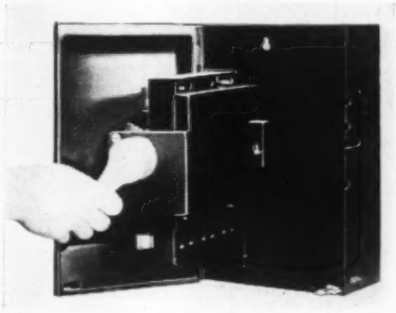
tractors, knife switch, receptacles for pilot lights to show the operator when power to the crane is alive, an instantaneous overload relay in one side of the line, and an inverse time element in the opposite side of the line for each motor and a separately mounted push button for closing the contactors or resetting them after they have been tripped by an overload. Two single pole contactors are used for the main line and are closed in sequence; this method of operation providing the feature that both are free to trip and will open immediately if an overload exists while they are being closed or at any

time when the crane is being operated.

Protective panels are built in the open style or they can be completely enclosed or front-enclosed. In all three styles the main line knife switch is arranged for padlocking in the open position to prevent operation of the crane during idle periods or when repairs or adjustments to the crane are desired.

Switches Permit Easy Assembly

GENERAL purpose 60-ampere and type C switches of Square D Co., Detroit, now incorporate the swing-out feature for interior parts. This design, shown herewith, permits the entire base and operating mechanism to be swung out and away from the box, leaving the entire box area accessible for bringing in conduit and wires. When the wiring has been completed, the base is swung back into normal position and secured by a setscrew. The base is also elevated from the back of the box so that wires may run underneath it, providing greater wiring space and permitting a neat installation.



Entire base and operating mechanism of new switch may be swung out away from the box

Pillow Blocks Are Self Aligning

SELF-ALIGNING pillow blocks especially developed to simplify alignment of shafts and to take care of light or heavy shock loads at either high or low speeds have been announced by Palmer-Bee Co., Detroit. These new units, shown herewith, are designed to withstand a greater shock load than a shaft of corresponding diameter as the housing is of cast steel. The bearing operates on a true ball and socket principle inasmuch as the housing is machine finished to a spherical surface and fit that permits a free oscillating movement of about three degrees maximum in any direction while maintaining accurate alignment of shafts. The pillow block is mounted with heavy duty precision bearings. It is especially suited for application in locations which are not readily accessible to maintenance men as it requires lubrication only

DESIGN ON PARADE

Through the centuries design has moved forward. Often hated, frequently fought, design progress could not be stopped.

Today the tempo has quickened. The parade doesn't wait for laggards!

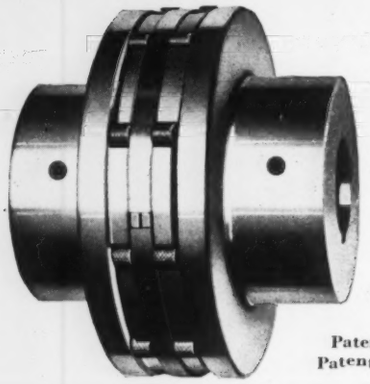
This parade is pictured in the pages of *Machine Design*. Every article is a record of progress from which the design engineer can adapt ideas to his own problems.

From the more than 6200 manufacturers of machines, from the thousands of makers of parts, materials and process equipment, from practicing engineers and the laboratory, the latest developments are brought to your attention.

Short, pertinent design topics are covered each month under the heading "Scanning the Field for Ideas."

Watch for these developments!

New L-R TYPE "W" FLEXIBLE COUPLING



Patented and Patents Pending

This new L-R Type "W" Flexible Coupling provides low first cost with highest efficiency on drives subject to shock loads or vibration. Improved construction. Free-floating load cushions always in plain sight and can be removed and replaced without tearing down coupling or disturbing drive or driven units. No lubrication. **Everlasting.** Sizes from 3¼" to 14" bores. Write for engineering data.

LOVEJOY TOOL WORKS

5018 West Lake Street **Chicago, Illinois**

WINTON comes to BANTAM

HERE is a string of thirty-six Winton Diesel Engines, 670 H.P. each, furnished recently for eighteen United States Coast Guard cutters. Each of these Winton Engines, like practically every other Diesel made, is equipped with Bantam Quill Roller Bearings.

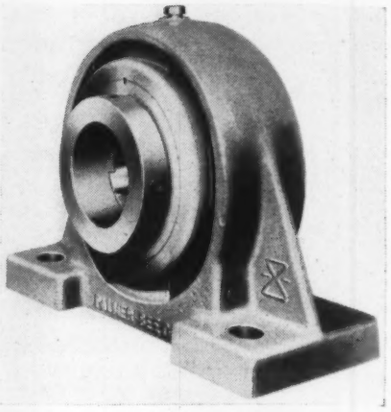
This is just one more indication of industry's rapidly growing reliance on Bantam. When you consider that 95% of the automobiles using Quill Bearings use Bantams, that practically all Diesel Engine builders use them and that there were more large Bantam installations listed in the steel mills during 1935 than all other makes combined, there are evidently some good reasons why you should use them in your product.

Write and tell us your requirements, or ask us to send a Bantam Engineer.

THE BANTAM BALL BEARING CO.
(Subsidiary of The Torrington Co.)
SOUTH BEND, INDIANA

BBB TAKE YOUR TOUGHEST BEARING JOB TO BANTAM

a few times a year. The unit is available in all standard shaft sizes for all types of service,

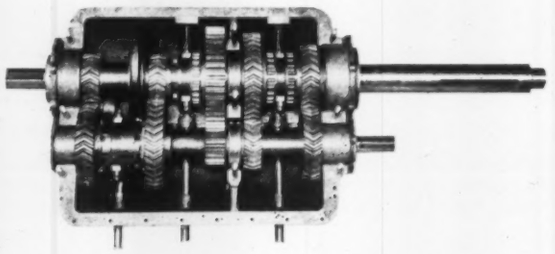


Bearing of self-aligning pillow blocks acts on a true ball and socket principle

while special sizes can be supplied on short notice.

Improved Transmissions Announced

WITH the addition of two new units in the intermediate class, Cotta Transmission Corp., 2300 Eleventh street, Rockford, Ill., has now completed its line of heavy duty transmissions to range in rating from 100 to 1500 foot pounds torque. The two new units are rated at from 500 to 1000 foot pounds and include all of the special features developed by the company for the complete line. Gears and shafts are heat-treated chrome nickel steels. Gears



Gears of improved transmission are constantly in mesh, permitting quick speed changes

are mounted on roller bearings, shafts on ball bearings. Gears are constantly in mesh, permitting quick speed changes with a minimum of deceleration.

As with all units built by the company, the new models, shown herewith, can be practically "custom-built" for each job's requirements. Either "admidship" or "unit" type, for engine or anti-engine rotation, various ratios, straight or angular take-off, from one speed forward and reverse, or two forward speeds to four forward speeds and one reverse, or five speeds forward can be provided.

Calendar of MEETINGS and EXPOSITIONS

HEADLINING the many valuable technical meetings scheduled for June will be the semiannual meeting of the American Society of Mechanical Engineers at Dallas . . . . This organization regularly presents papers which are worthy contributions to engineering literature * * * At Dallas the fast changing developments in railroad and transportation equipment will be given special attention . . . . Guy Bean will discuss railroad lubricants and fuel oil in presenting "Equipment Problems in Handling Oil as a Locomotive Fuel" . . . . Much the same topic will be covered in further detail by a paper on "Fuels for Today's and Tomorrow's Engines," by Earl Bartholomew and C. H. Howley * * * The design of diesel electric oil well drilling units is to be covered by D. M. McCargar and O. A. Hass . . . . H. G. Hiebeler will present the design and operating features of the 1450-pound deep water station * * * In addition, many other topics of interest to mechanical engineers will be given full coverage.

June 8-12—

National Confectioners Association of the United States. Annual meeting and exposition of equipment to be held at Waldorf Astoria hotel, New York. Max F. Burger, 111 West Washington street, Chicago, is secretary.

June 8-12—

American Water Works association and Water Works Manufacturers association. Annual meeting and exhibition of equipment to be held at Hotel Biltmore, Los Angeles. B. C. Little, 29 West Thirty-ninth street, New York, is secretary of the Water Works association.

June 15-20—

American Society of Mechanical Engineers. Semiannual meeting to be held in Dallas, Texas. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

June 22-24—

American Society of Heating and Ventilating Engineers. Semi-annual meeting to be held at the Inn, Buck Hill Falls, Pa. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

June 22-25—

American Society of Agricultural Engineers. Annual meeting to be held at Stanley hotel, Estes Park, Colo. Raymond Olney, St. Joseph, Mich., is secretary.

June 22-26—

American Institute of Electrical Engineers. Summer convention to be held at Huntington hotel, Pasadena, Calif. H. H. Henline, 33 West Thirty-ninth street, New York, is national secretary.

June 29-July 3—

American Society for Testing Materials. Annual meeting to be held at Chalfonte-Haddon Hall, Atlantic City, N. J. C. L. Warwick, 260 South Broad street, Philadelphia, is secretary.

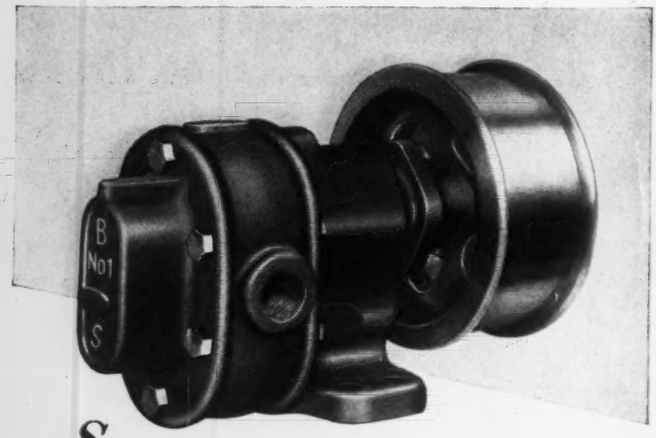
for MACHINE Performance specify MODERN Chain Drives

Chain drives gain increasing acceptance year by year as a means to profitable machine performance. The field of application for this positive and efficient power transmission medium has constantly widened, because modern chain drives have kept in step with improved manufacturing methods and materials.

Whitney Chain Drives are recognized as outstanding in performance. They have strength for the most severe operating conditions and a high resistance to wear, which helps to maintain original accuracy and smoothness of operation.

Whitney Chain Drives are specified by leading designers, manufacturers and plant engineers. Their inherent characteristics allow a freedom of design which is unequalled by other types of drives. Whitney engineers can offer valuable suggestions on your power transmission problems. Write today for further information.

The Whitney Chain & Mfg. Co., Hartford, Conn.



Specify 1S - 2S - 3S
for—Quietness—Long Life

. . . and besides, these modern rotary geared pumps can be run at High Speeds.
Important features are: helical gears — renewable bearings—well balanced design.
Write—Brown & Sharpe Mfg. Co.
Providence, R. I.

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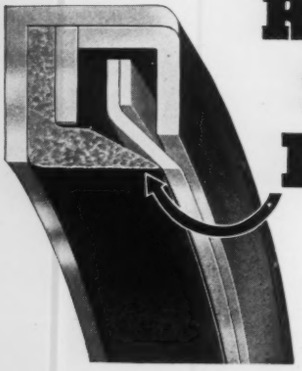

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GITS Precision Oil Seal

Gear Makers Study Welded Plus Cast Design

(*Concluded from page 37*)

below 0.20. Quenching action of thick sections is as important in castings as in rolled plate, and nonweldability of certain castings hinges on this point. The only other precaution is that joints to be welded should be thoroughly cleaned down to bright metal.

Minimizes Noise from Gears

In discussing the prevention of gear noises, Mr. Chapman explained that a new type of gear employing conical webs has homogeneous rigidity from point to point. As each point goes past the pinion and is successively loaded by the pinion tooth pressure, the deflection of the rim is kept uniform. This is a large factor in the elimination of the periodic groans that sometimes occur in a spoked wheel.

Standard procedure in determining the size and horsepower capacities of gears of different materials was presented by G. E. Katzenmeyer, National-Erie Corp. While the nature of the paper makes it impracticable to attempt an abstract in limited space, it will interest the designer to know that the information is available and is compiled to assist the engineer in designing a set of gears, since by comparison he can select the most economical and best type of gearing to suit the conditions involved. The data will be useful to those who prefer to use comparison tables or charts rather than to solve complicated mathematical equations, and who thereby can compare various materials, tooth forms, pitches and types of gearing without doing a considerable amount of calculating.

Tapered Roller Bearings Discussed

Probably the most important advantage to be obtained from the use of roller bearings is accuracy of alignment of the gears, S. M. Weckstein, Timken Roller Bearing Co., brought out in his discussion on the "Use of Tapered Roller Bearings in Gear Reduction Units." Many of the troubles encountered in the past have been due to inaccurate gear cutting, faulty alignment or a combination of both. Even if the gears were cut accurately, uneven wear in bearings caused misalignment with consequent rapid gear wear, he explained. Assurance of constant alignment of gears has led to adoption of roller bearings in all sizes of units.

It should be remembered that the shaft on which the bearings are mounted plays an important part in maintaining rigidity of the unit. Sharp undercuts should be avoided and liberal fillets used. Stepping of the shaft should be

avoided as far as possible. With the tapered roller bearing this elimination is made possible because of the wide selection of bearing bores within a given outside diameter of the bearing.

New Officers Are Elected

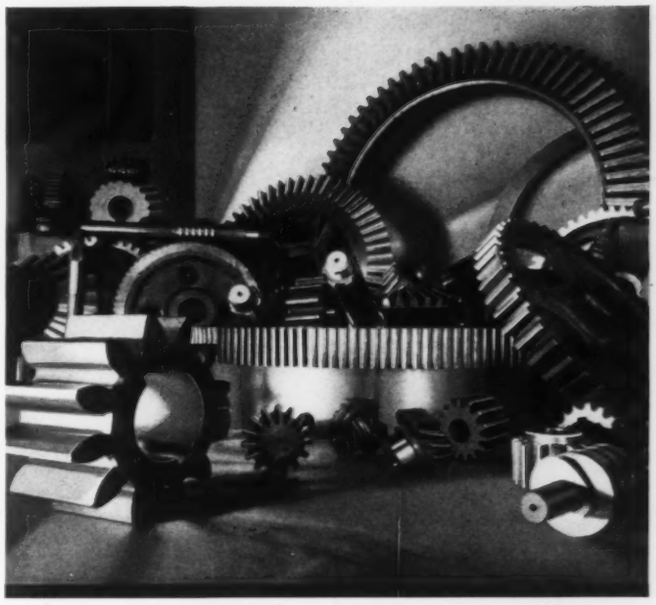
During the business session of the annual meeting E. S. Sawtelle, vice president and general manager, Tool Steel Gear & Pinion Co., Cincinnati, was made president of the association. The new vice president is H. H. Kerr, president, Boston Gear Works, Inc., North Quincy, Mass.

New directors to serve for a three-year period are H. H. Fowler, Foote Bros. Gear & Machine Co., Chicago; J. H. Flagg, Watson-Flagg Machine Co., Paterson, N. J.; Charles Goedke, Ganschow Gear Co., Chicago; and W. G. Jones, president, W. A. Jones Foundry & Machine Co., Chicago.

An extremely interesting paper on "Marine Gearing" was presented by Ira Short of Westinghouse, and another on "Gear Noise—Causes and Corrections," by W. E. Sykes of Farrel-Birmingham. Both will be given consideration in the next issue.

Studies Worm Gear Contact

CONSIDERABLE uncertainty exists as to the exact nature of the contact between the worm and the worm gear on the many and various designs of this type of drive which are now available. The analysis of the exact contact conditions on any worm drive is a tedious operation, and but few appear to have the time or the patience to make them. Lacking the precise information available from such analyses, it is easy to imagine and claim all sorts of contact conditions for any pet design. For example, surface contact is sometimes claimed for the Hindley worm and some of its variations. With rigid bodies and actual surface contact on any drive except one with the same axis for both members of the pair (such as a screw and nut), smooth continuous action is impossible. Some difference in the curvature of the contacting surfaces is necessary to permit the relative rocking involved in the transmission of smooth continuous motion. Considering elastic bodies—and all our materials of construction are elastic—all worm gear contact is surface contact to a greater or less degree. The amount of this surface contact depends upon the relative curvatures of the contacting surfaces, the elasticity of the materials and the intensity of the load."—Prof. Earle Buckingham, Massachusetts Institute of Technology, from a paper prepared for the worm gear committee of American Gear Manufacturers Association.



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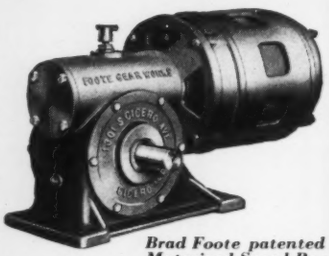

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Consider the Pump—Vital Part in Machines

(*Continued from Page* 40)

possible directly into the pump under head. The suction, however, should be arranged so that whirlpools and eddies are not existant at the entrance to the pump suction pipe as this would tend to draw in air and cause noisy pumping which would further result in the impossibility of securing full capacity ratings. Suitable strainers are often necessary with pumps as most of the units forming integral parts of another machine are small units and have narrow impeller passages which are not designed to pass solid material. As before noted, however, there are designs available which will pass solutions which are only about 10 per cent liquid. An example is the pump on the paint mixing machine of *Fig.* 9 which handles solutions that are almost a solid. A strainer will, however, eliminate any possibility of the hazard of solids clogging a pump not especially built for the service.

May Require Antifriction Bearings

Grease cups can be used for lubrication purposes to increase the life of pumps handling nonlubricating liquids, and where a slight grease contamination of the liquid is not harmful or objectionable. Pumps operating at low speeds and pressures work satisfactorily on plain bearings which are lubricated either by the liquid pumped or by grease cups as noted. Pumps operating at high speeds and pressures should have ball, roller or needle bearings because of the bearing loads.

The selection of a particular pump for a specific design is based on the features of the pump. Centrifugal pumps are adapted to handle large volumes at relatively low head. Certain of these have ample clearance to handle chips and grit without damage. They require no relief valve and have a fairly uniform power consumption. Geared (or vane) pumps are adapted to furnishing substantially constant volumes at any predetermined pressure (within the limits of the pump). Spur geared pumps offer an inexpensive design adapted for installation where noise, vibration, maximum power, efficiency and smoothness of flow are not primary requirements. Spiral geared pumps of proper design allow operation at high speed with freedom from noise and power loss and give a uniform flow. Pumps handling abrasive materials in the liquid must have bearings which are protected from the liquid.

Rotary pumps are available and are used in many composite designs. These are particularly desirable for handling viscous liquids of an oily nature without grit and are not particularly adaptable or desirable for water unless the

metals have been selected to prevent corrosion. Such a design is shown in *Fig.* 8, where the pump is used to circulate cooling water for the engine used to drive oil well drilling equipment. Rotary pumps handle with efficiency every conceivable type of grit-free liquid—from water and gasoline to such viscous materials as molasses and yeast. These pumps are also widely used in spraying preheated oil on to coal where due to pressure requirements a positive suction and discharge pump is needed. Another application is the spraying of palm and other protective oils on sheet steel, castings and parts while an automobile spring spraying unit uses a pump of this type.

An additional pump design which will handle

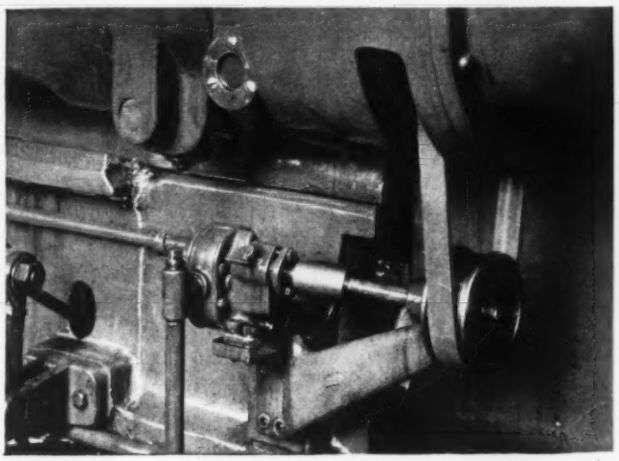


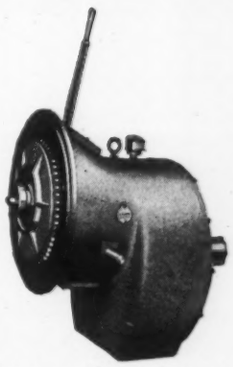
Fig. 9—Outside support, driving coupling, and priming means complete the design of this pump application

extremely viscous liquids is the piston type used in the bearing lubricant tester of *Fig.* 5 and the paint mixing machine of *Fig.* 6. In this design there are two reciprocating pistons at right angles to each other in a rotor. As the rotor turns, the pistons reciprocate in turn, giving a simultaneous pumping and suction action, or four strokes for each revolution of the rotor. While these pumps give continuous flow with especially small amounts of slippage, they are not adaptable for pumping abrasive fluids.

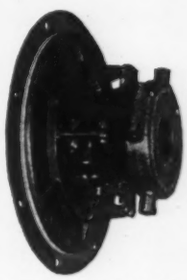
Small triplex power or single-acting single or duplex pumps, vertical or horizontal, are used in many general combinations. Due to the size and bulk they are in the minority in a great many types of assembled equipments. However, they have their proper place and this can only be determined after all factors entering into the adaptation of a pump for any given service are considered. There are alternatives wherein instead of the centrifugal or the rotary, small power pumps of the straight reciprocating type can be installed. These have the disadvantage of requiring more space although they are adapted to all kinds of service.

The selection of pumps for coolant purposes

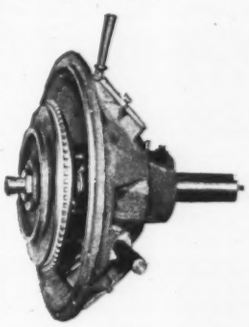
HOW IMPORTANT *is the* CLUTCH?



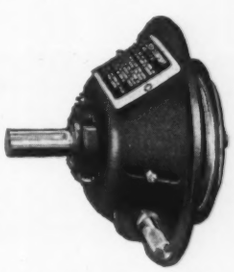
No. 8301 Reduction Gear Unit for General Industrial Use.



No. 5738—C-10 Toggle Action Clutch for use on Tractors.



No. 7350 G. T. Gear Tooth Power Take-Off Unit for General Industrial Use.



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varies somewhat with the requirements. Such pumps used on grinding machines are frequently of the centrifugal type, the reason for this being obvious as the abrasive normally in the coolant would quickly cause the deterioration of pump bearings with which it may come in contact. These same reasons admirably fit rotary pumps to this service.

Pumps mounted outside are sometimes used, the preferable installation being a vertical submerged unit, or an integral motorpump such as shown in *Fig.* 4. Centrifugal and rotary types are satisfactory for pumping volume at low pressure, and as this is the average coolant requirement for machinery, these types now are being used more and more for this purpose. The vertical centrifugal type has wide favor because less liquid depth is necessary, it will operate at full volume if the impeller is merely immersed, and it permits a greater variation in the amount of liquid carried in the reservoir.

Coolant pumps for nonabrasive liquids, as on milling machine, etc., are of any type, although the centrifugal, perhaps, works out as advantageously as any, due to the ample space for chips, low shutoff pressure, etc. A desirable application is a submerged unit. However, on machines where more pressure is required to force coolant into deep holes, etc., geared pumps are very well suited, and particularly the geared motorpumps which can be attached in a convenient location without necessarily changing the design of the machine. At low speeds and low pressures indirect drives, either belt, chain or geared are practicable. However, at higher speeds and pressures the use of a direct drive is desirable. In certain installations the use of an outboard bearing is an advantage.

The use of stock units is, in general, much more economical than the employment of specially built units to meet a particular demand which, necessarily, are more costly, although in many instances special units are essential. Frequently, it is possible to adapt stock parts to special applications at a considerable saving in cost. However, specialists in pumps have units for practically every type of application that may be encountered. Thus the designer may select a unit which will satisfy his particular application exactly and economically.

Inasmuch as pumps for providing hydraulic power are in a distinctly separate field of application which has been covered extensively in previous issues of MACHINE DESIGN, they have not been considered in this article.

For their considerate assistance in the preparation of this article and for the illustrations used, MACHINE DESIGN wishes to thank: Allis-Chalmers Mfg. Co.; Brown & Sharpe Mfg. Co.; Globe Products Co.; Ruthman Machinery Co.; Viking Pump Co.; and Worthington Pump & Machinery Corp.

Beryllium Copper Springs Require Modified Design

(*Concluded from page* 33)

the value given by the usual heat treatment is approximately 7,000,000. Before heat treatment the value is about 5,500,000, and this lower value substituted in equation (1) gives the deflection that must be obtained in the spring before heat treatment in order to secure the desired stiffness in the heat treated spring.

During the first stages of heat treatment, as previously indicated, the elastic modulus increases at about the same rate as the hardness. With continued heat treatment, however, the modulus values continue to increase after no further increase in hardness is found; in other words, the maximum modulus value is obtained by heat treatment for a longer time than is required for maximum hardness. The amount of added modulus increase thus obtainable is about 5 per cent. Also, the maximum value for the modulus is somewhat higher for heat treatments at higher temperatures.

This change in modulus may seem to be somewhat of a disadvantage but the effect can be converted readily into a convenient shop method for obtaining precise stiffness values merely by controlling heat treating time or temperature. Thus, the last 5 per cent change in stiffness can be used readily to adjust the spring strength to the required value. Since the stiffness changes occur only while the springs are at temperature, they can be repeatedly heated until the desired properties can be obtained.

Articles on this and related subjects published in previous issues of MACHINE DESIGN include:

"Use Springs to Relieve Springs," May, 1934, p. 25.

"Graphs Facilitate Solution of Spring Problems," by John S. Carpenter, May, 1934, p. 34.

"Practical Aspects of Spring Applications," by E. W. Weaver, June, 1934, p. 31.

"Winding Helical Silica Springs," July, 1934, p. 31.

"Springs Combat Inertia," by J. E. Fenno, Nov., 1934, p. 41.

"Utilizing Stored Energy in Mechanical Springs," by William M. Emery, March, 1935, p. 21.

"Flat Springs Regulate Counter Operation," by L. G. Randall, July, 1935, p. 34.

"Automatic Adjustment with Springs," Sept., 1935, p. 33.

"Don't Overlook Surge in Designing Springs," by C. H. Kent, Oct., 1935, p. 37.

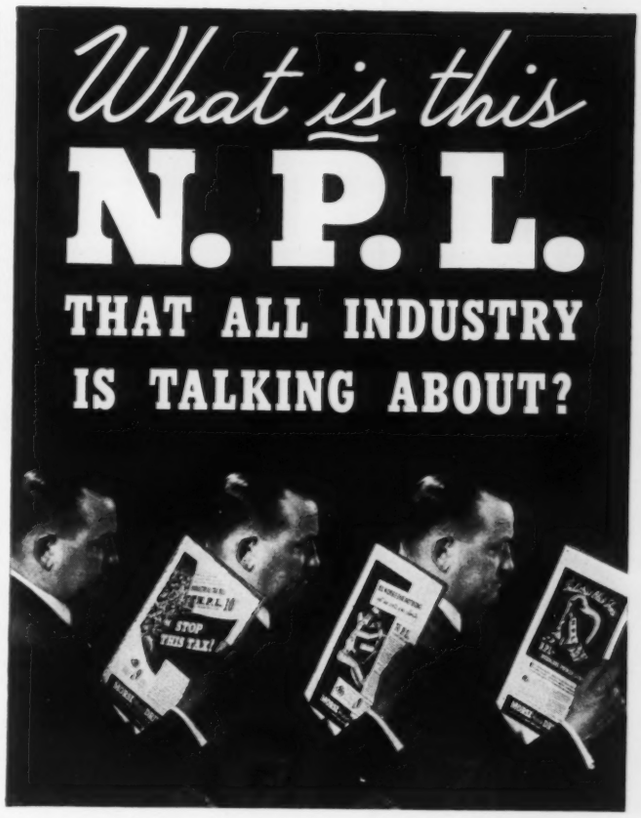
"Determines Spring Surge Frequency," by Carl P. Nachod, Jan., 1936, p. 47.

"Easing the Designer's Load in Selection of Springs," by Harold W. Whiting, Feb., 1936, p. 19.

"Rubber Makes Air Spring Possible," March, 1936, p. 20.

"Designing Helical Springs," by Robert C. Jordan, Charles P. Grimes, A. M. Wahl, and Harold W. Whiting, April, 1936, p. 49.

A further listing of earlier spring articles is given on Page 35 of the May, 1934 issue of MACHINE DESIGN.



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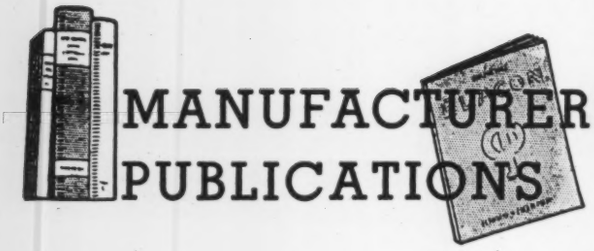


MANUFACTURERS' PUBLICATIONS

ALLOYS (IRON)—A complete specification chart and recommended grades of the material sponsored by Meehanite Metal Corp., Pittsburgh, is given in Research Bulletin No. 6 of the company which includes a summary of the characteristics of the grades.

ALLOYS (NICKEL)—Data on low temperature properties of nickel alloy steels, covering both the results of research and of service in practical applications, are included in a new bulletin of International Nickel Co. Inc., 67 Wall street, New York, entitled "Safe Steels for Sub-Zero Service."

BEARINGS—Lignum-vitae, the self-lubricating hardwood used for bearings in applications where it is important that lubrication does not get on to the work, or where periodical lubrication is impossible, is completely described in a publication of Lignum-Vitae Products Corp., 98 Boyd avenue, Jersey City, N. J. The publication gives characteristics of the material and physical properties.

BEARINGS — Leaded phosphor bronze electric motor service bearings are completely listed in catalog EM-6 of Johnson Bronze Co., New Castle, Pa. Each bearing is illustrated and is included in alphabetical, numerical and progressive listings. Other sections of the catalog are devoted to general purpose bearings, and completely machined bronze bars.

CAST PARTS—Centrifugal castings of chrome iron, chrome nickel and nickel chrome as produced by Duraloy Co., Pittsburgh, are covered in a folder of the company which gives details on the process, advantages, analyses of metals and size of tubes, applications, and machining and welding data.

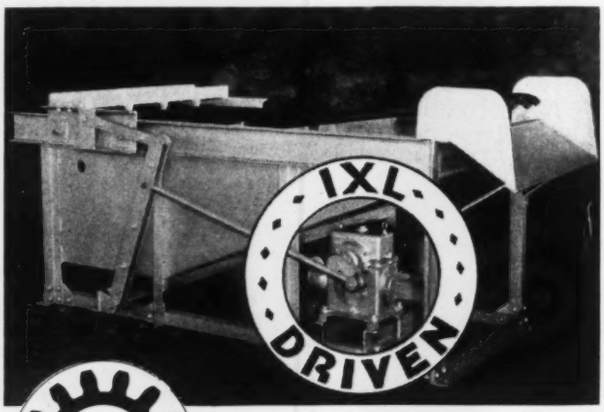
CONTROLS (ELECTRICAL)—Condit Electrical Mfg. Corp., Hyde Park station, Boston, is distributing a number of catalog inserts on its line of oil circuit breakers, accessories and feeder equipment.

CONTROLS (ELECTRICAL)—Compact pilot switches for sensitive control of a wide variety of electrical applications and circuits, including use as a limit switch, are presented in a bulletin of Production Instrument Co., 1325 South Wabash avenue, Chicago.

FASTENINGS—All standard dimensions of heads, bodies, screw and thread lengths, screw points and sockets for hexagonal type socket, set and cap screws and wrenches are given in bulletin HK166 of Holo-Krome Screw Corp., Bristol, Conn. The dimensions are the recently approved standards of American Standards association and were sponsored by Society of Automotive Engineers and American Society of Mechanical Engineers.

GEARS—Ohio Gear Co., 1333 East 179th street, Cleveland, is distributing a bulletin which describes its complete line of spur, bevel, worm and other gears, and motorized speed reducers. The publication includes tech-

A fine Machine Deserves a Drive that will help SELL IT!



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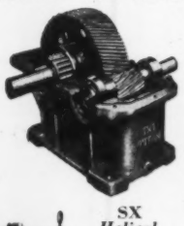
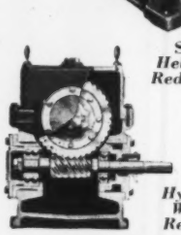
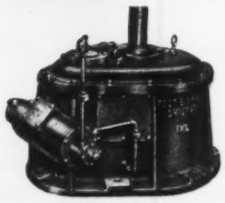


SX
Helical Reducer



Hygrade Worm Reducer



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nical data on gearing, SAE standard heat treatment methods, etc.

MOTORS—Details on the fractional horsepower motors built by Ohio Electric Mfg. Co., 5900 Maurice avenue, are given in an attractive booklet recently published by the company which illustrates and describes the many testing and assembly steps in the production of the motors.

MOTORS — Complete details on fully enclosed, fan-cooled, heavy duty motors for direct current applications in locations where the motors are exposed to dirt, iron dust, oil, moisture or injurious fumes are given in two new publications of Reliance Electric & Engineering Co., Ivanhoe road, Cleveland, bulletins 213 and 214.

MOTORS—A summary of the operating characteristics and recommended applications of fractional horsepower motors built by Bodine Electric Co., 2258 West Ohio street, Chicago, is given in a new bulletin, No. 1020, just published by the company. The bulletin outlines the entire line of motors built by the company.

PLUGS (ELECTRICAL)—Bulletin 198 of Pyle-National Co., 1334 North Kostner avenue, Chicago, describes and lists all types and sizes of the new series of plugs and receptacles for multiple circuits of from 4 to 16 poles recently announced by the company.

SHAPES—Union Drawn Steel Co., Massillon, O., is distributing a new bulletin which illustrates a variety of parts made from the company's cold drawn stock and gives the reasons for some of the applications.

TUBING—Steel & Tubes Inc., 222 East 131st street, Cleveland, has announced a new handbook of electric weld tubing which has been published under the supervision of the Formed Steel Tube institute. The handbook is intended to give a knowledge of the applications of welded steel tubing, its physical, chemical and metallurgical properties, commercial tolerance limitation and engineering data.

WELDED PARTS AND EQUIPMENT—The technique of fusion welding brass and bronze is completely presented in a recent publication of Linde Air Products Co., 30 East Forty-second street, New York. The booklet contains a section on the welding of yellow brass pipe, including details on joint design. Tables give material consumption and tensile strengths of welds made in various positions.

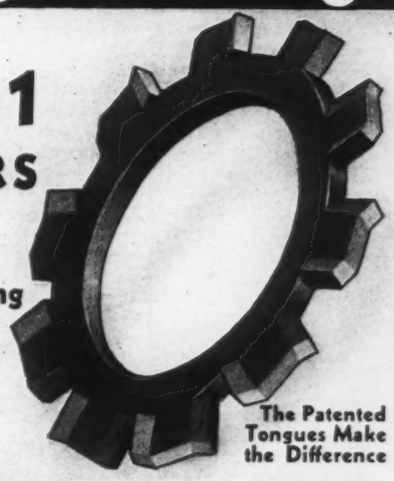
Research Publications

Simplified Practice Recommendation for Taper Roller Bearings. Minor changes suggested by interested organizations have been incorporated in this revised recommendation recently issued. Bulletin R 67-36 may be obtained from Superintendent of Documents, Government Printing Office Washington.

American Lubricating Greases, by James I. Clower. This publication is a complete exposition of this subject, covering the manufacture of greases, physical, chemical and mechanical tests and their significance, the question of grease or oil lubrication, methods of application, specifications, of greases and the care that should be taken in drawing up these specifications, and a most complete table which gives the classification, composition and uses of various types of greases. Published as bulletin No. 35, Engineering Experiment Station series, Virginia Polytechnic Institute, Blackburg, Va. 80 pp.

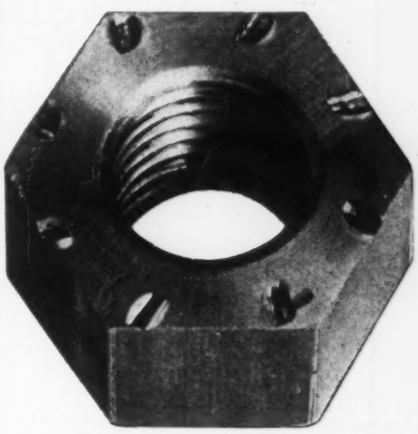
When other Lock Washers Fail Use Everlocks

THE 2 IN 1 WASHERS that Combine Positive Locking and Powerful Spring Tension



The Patented Tongues Make the Difference

In case after case where other lock washers fail, Everlocks have made good.



This halftone reproduction of an unretouched photograph shows why. With the many sharp teeth forced into the nut by powerful spring tension positive locking is assured—vibration can never shake it loose.

Why subject your equipment to the hazards of loose nuts, when positive locking, combined with spring tension costs so little?

Write for free testing samples and judge for yourself Everlock positive protection against loosened nuts.

Everlock

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Thompson-Bremer & Co.

1640-G West Austin Avenue - Chicago, Illinois

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For the economical handling of all grit-free liquids specify Viking Standard Rotary Pumps. Capacities of 2/3 to 1050 G.P.M. For the actuation of all machine tool movements, broaches, drills, etc.—for the operation of hydraulic elevators and lifts, use Viking Hydraulic Oil Pressure Pumps. Capacities of 5 to 45 G.P.M. designed for 300 pounds continuous, up to 500 pounds per square inch intermittent, service. For all cooling applications use Viking Coolant Pumps. Write for Special Hydraulic-Coolant Pump Bulletin and Prices.

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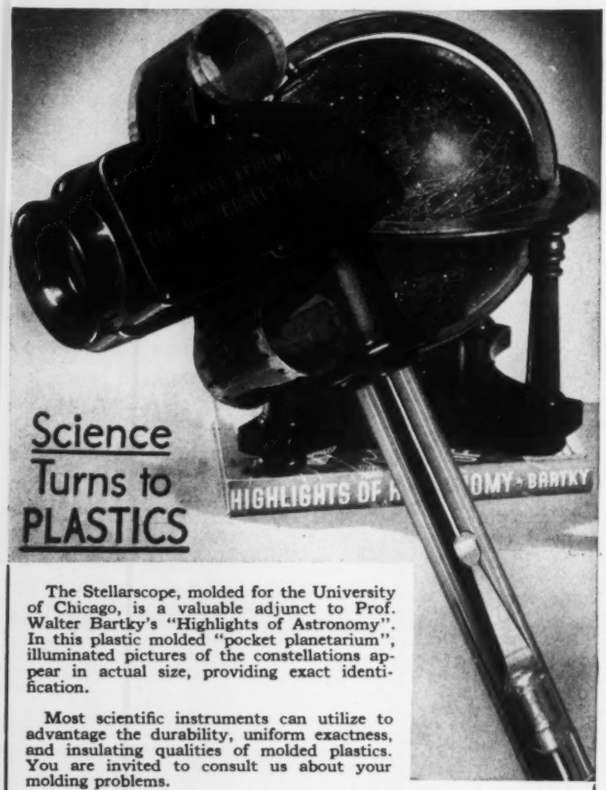

Science Turns to PLASTICS

The Stellarscope, molded for the University of Chicago, is a valuable adjunct to Prof. Walter Bartky's "Highlights of Astronomy". In this plastic molded "pocket planetarium", illuminated pictures of the constellations appear in actual size, providing exact identification.

Most scientific instruments can utilize to advantage the durability, uniform exactness, and insulating qualities of molded plastics. You are invited to consult us about your molding problems.

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INDEX TO ADVERTISERS

Allen-Bradley Co.	3
Allis-Chalmers Mfg. Co.	*
Baldor Electric Co.	*
Bantam Ball Bearing Co.	78
Bearings Company of America	19
Bethlehem Steel Co.	*
Bliss & Laughlin Inc.	*
Bodine Electric Co.	*
Booth Felt Co.	82
Boston Gear Works Inc.	*
Brown & Sharpe Mfg. Co.	80
Bruning, Charles, Co., Inc.	52
Century Electric Co.	17
Chicago Molded Products Corp.	88
Chicago Rawhide Mfg. Co.	4
Cleveland Worm & Gear Co.	75
Climax Molybdenum Co.	67
Conway Clutch Co.	*
Cumberland Steel Co.	70
Cutler-Hammer Inc.	Back Cover
Diamond Chain & Mfg. Co.	71
Diehl Mfg. Co.	68
Dietzgen, Eugene, Co.	*
Drop Forging Association	12
Dumore Co.	60
Emerson Electric Co.	*
Electro Metallurgical Co.	55
Fafnir Bearing Co.	14
Fairbanks, Morse & Co.	9
Farval Corp.	*
Felters Co. Inc.	84
Foote Bros. Gear & Machine Co.	86
Foote Gear Works Inc.	82
Formica Insulation Co.	*
Garlock Packing Co.	*
General Electric Co.	13
General Electric Vapor Lamp Co.	57
General Radio Co.	56
Gibson, Wm. D., Co.	*
Gits Bros. Mfg. Co.	80
Globe Products Co.	74
Graton & Knight Co.	90
Hoover Ball & Bearing Co.	*
Hyatt Roller Bearing Co.	*
International Nickel Co.	61
James, D. O., Mfg. Co.	Inside Front Cover
Johnson Bronze Co.	*
Laminated Shim Co. Inc.	70
Leiman Bros.	72
Lincoln Electric Co.	59
Linde Air Products Co.	8
Lovejoy Tool Works	78
Marlin Rockwell Corp.	53
Master Electric Co.	22
Morse Chain Co.	85
National Motor Bearing Co. Inc.	16
New Departure Mfg. Co.	6
New Jersey Zinc Co.	63
Norma Hoffman Bearings Corp.	54
Ohio Forge & Machine Corp.	81
Paragon-Revolute Corp.	76
Pease, C. F., Co.	64
Peerless Electric Co.	58
Philadelphia Gear Works	Inside Back Cover
Production Instrument Co.	*
Reeves Pulley Co.	21
Rivett Lathe & Grinder Corp.	*
Roots-Connersville Blower Co.	*
Shafer Bearing Corp.	73
Shakeproof Lock Washer Co.	66
Sherwin-Williams Co.	*
Spring Washer Industry	18
Standard Pressed Steel Co.	74
Thompson-Bremer Co.	87
Timken Roller Bearing Co.	65
Twin Disc Clutch Co.	83
Union Carbide & Carbon Corp.	8, 55
United States Steel Corp.	15
Valley Electric Corp.	62
Veeder-Root Inc.	69
Viking Pump Co.	88
Waldron, John, Corp.	72
Waukesha Foundry Co.	76
Westinghouse Electric & Mfg. Co.	10, 11
Whitney Chain & Mfg. Co.	79
Wilmington Fibre Specialty Co.	*

*Advertisements appear in previous issues.

Business and Sales Briefs

CUTLER-HAMMER INC., Milwaukee, manufacturer of electric control apparatus, has opened a new office in Baltimore for the states of Maryland and Virginia. The office is located at 10 West Chase street in Baltimore and will operate under the supervision of the Philadelphia district office. The Baltimore office will be in charge of R. A. Haworth.

* * *

L. F. Mullen, 2563 Fenwick Road, Cleveland, formerly Cleveland district manager for Synthane Corp., is now representing Thiokol Co., Trenton, N. J., manufacturer of synthetic rubber products.

* * *

Reese James has been appointed Detroit sales manager for National Alloy Steel Co., Pittsburgh.

* * *

The Chicago offices of New Departure Mfg. Co., manufacturer of ball bearings, has been removed to the Carbide & Carbon building, 230 North Michigan avenue.

* * *

Allen-Bradley Co., Milwaukee, manufacturer of motor control equipment, has moved its New York office to larger quarters in the Underwood building, 30 Vesey street.

* * *

A. F. Dobbrodt has been transferred from the Chicago office of Carboloy Co. Inc., manufacturer of cemented carbide materials, to Milwaukee where he is located at 2802 Atkinson avenue.

* * *

Chas. M. Bailey Co. Inc., 342 Towne avenue, Los Angeles, has been appointed as representative for air valves, gages, thermometers and industrial instruments built by Jas. P. Marsh Corp., Chicago, in the Southern California territory.

* * *

R. L. Foote is now district manager in the Cleveland district for Synthane Corp., Oaks, Pa., manufacturer of laminated phenolic products. Mr. Foote, formerly located at the factory of the company, will maintain offices at 430 Penton building, Cleveland.

* * *

Norbert E. Smith has joined the staff of Inland Steel Co. as a member of the sales department with headquarters in Chicago. Mr. Smith, associated with Joseph T. Ryerson & Son Inc., for the past 15 years, will cover certain territory in Indiana, Ohio and Kentucky.

* * *

Michigan Tool Co., Detroit, has expanded its manufacturing facilities in line with increasing business and a broadening of the company's products. The present expansion, in the form of a 20,000 square foot wing adjacent to the main plant, has been completely equipped and tooled for the production and assembly of special machinery.

* * *

George E. Olmstead, New Haven, Conn., who has been operating as manufacturer's agent in Connecticut, has joined the staff of Morse Chain Co.'s New York office. Mr. Olmstead will continue to cover the state of Connecticut, being located in New Haven. E. H. Jessop, formerly with Morse Chain Co. at Ithaca, N. Y., is now in charge of chain sales with Tranter Mfg. Co., 105 Water street, Pittsburgh.

CROSS SECTIONS

A NEW gadget has been developed which automatically turns off the ignition in an automobile should it overturn. Mercury tubes do the trick. The device eliminates the fire hazard from this cause. Why not arrange this unit with an inertia weight in airplanes so that any sudden stopping will accomplish the same action?

OF FAR reaching importance to designers is the fact that within a few months the Strauss chrome-nickel patents expire. These patents cover many of the well-known alloys in use today. The range includes steel alloys containing 6 to 25 per cent chromium and ½ to 20 per cent nickel, and alloys with 15 to 40 per cent chromium and 4 to 20 per cent nickel.

STEELMAKING rates have so far resisted the usual spring dip, a most encouraging omen. The top rate in April was exceeded by only the mystic days of February-June, 1930. Neglecting this period, we have to go back to November 1929 to get a figure that tops the recent pace.

AUTOMOTIVE seers predict that all cars will soon have redesigned cooling systems which in effect will simply provide for the substitution of a pressure pump for the present suction pump, thus reversing the present flow of water. Improved motor cooling and more efficient heater operation is predicted with the water being drawn from the bottom of the block and being forced up through the radiator from the bottom.

DESIGNERS have succeeded in eliminating another of the minor annoyances that has been with us entirely too long. No longer will it be necessary to string telephone equipment all over the office. A new desk type phone has all of the equipment, the bell, and arrangement for office intercommunication all in the base of the set, and this hand-set is no larger than the previous types in which space was wasted.

THE APPLICATION of the word "babbitt" to tin base bearing metals has been a practice for so many years that few realize this versatile alloy was named after Isaac Babbitt who was granted a U. S. patent nearly a hundred years ago. The original babbitt was composed of 90 per cent tin with the remainder antimony and copper.

DECENTRALIZATION of industry is a project that should receive the whole-hearted support of the engineering department. You metropolitan sophisticates who don't believe it, should visit your brothers in the smaller industrial towns sometime and be convinced. Plants in the smaller cities are surprisingly free from noise and dirt and enjoy a maximum of sunlight. The designer rides to work in from ten to fifteen minutes, and within half an hour after he quits he can be down the fairway on the first hole. All without rush or bother.